ANOTHER DISASTROUS BUTTING COLLISION.

Before the newspapers have got through with their editorial discussions on the collision in Tennessee, Sept. 24, in which threescore passengers were killed, they are called upon to record a similar disaster in Missouri (Oct. 10), killing 28. Following closely the Colorado disaster, in which over 90 passengers were drowned, and lesser train wrecks at Pendleton, Mo., Tiskilwa, Ill., and Monroe, N. C., these horrors have aroused the press to unusual activity; but to what purpose? Two New York papers have interviewed such railroad presidents as they could induce to speak, and one has printed a lot of letters from life-insurance and accident-insurance experts; but not a word of instruction is to be found in any of these productions. Bridge disasters and butting collisions have never yet been successfully dealt with by the same remedy, and yet these and other classes of accidents are included in a single prescription by some of these journalistic doctors. The use of strong frames in all new cars hereafter built will afford no comfort to one who has to ride in an old car, and yet this is the only remedy suggested for preventing deaths in traveling egg-shells. The lessons of all these collisions and wrecks are as clear as daylight and have been repeated frequently—at least every year—ever since Mr. Forney began to preach in the columns of this paper the gospel of safe railroading, more than 30 years ago; and *no one disputes this preaching.* Any one who finds the *Railroad Gazette* dull reading—we admit that on accidents it seems to us just a trifle monotonous—might turn to the last annual report of the Interstate Commerce Commission, a condensation of which was given in these columns Dec. 25, 1903, and January 1, 1904. There is no lack of knowledge; all that is needed is to apply it.

The *Railroad Gazette* has advocated the block system at all times as the one effectual preventive of collisions on main lines outside of yards (in which speeds can be regulated by fixed signals). The suggestion made by Mr. Forman recently in these columns, that telegraphic meeting orders be sent to meeting stations, as well as to the trains which are to meet each other, is excellent as far as it goes; but it provides against only one class of collisions, and only at stations where operators are on duty. The block system provides against all classes. When attention is concentrated on a butting collision of such magnitude as that at Hodges, Tenn., other dangers are liable to be forgotten; but when there is a single practicable remedy which provides against all possible causes, the only rational course is to apply that one.

On the question of forgetfulness in enginemen two things may be said. First, many persons seem to be confused by the fact that enginemen sometimes disregard block signals, as well as other signals, indicating that mental lapses cannot be wholly cured by the adoption of the block system. But the fact remains that the methodical procedure imposed by the block system affords the best known means of inculcating right mental habits in enginemen. This is confirmed by experience. Second, it is to be observed that the requirement, recently made somewhat general, that other men on the train shall read meeting orders, besides the conductor and enginemen, has not produced any marked improvement. So far as can be known without getting answers—honest answers—from all the enginemen of the country, there has been no improvement whatever. The principal trouble seems to be that the additional monitors are subordinates. A subordinate does not naturally assume responsibility. At Frankford, Pa., recently a brakeman called a conductor's attention to a forgotten meeting point, but too late to prevent the collision.

The danger of running weak cars in the same train with strong ones was strikingly exemplified at Hodges, but no more clearly than in numberless cases before. Sleeping cars must be run at the rear of trains because the day-cars, doing the way business and carrying the larger proportion of passengers, must be close to the baggage car and mail car, so that all can be stopped in convenient positions at small stations. Sleeping cars must be made heavy and strong in the lower part, in order to support the upper berths, to keep the center of gravity low and to insure smooth riding under varying loads. The only satisfactory rule for making up trains is to have all the cars of equal longitudinal strength. Putting light cars behind heavy ones would favor the light ones in a butting collision, but might harm them in a rear collision. In the majority of derailments probably the weak cars would fare better at the rear than in front. The reason why railroad managers continue to run strong and weak cars together in the same train, the weak at the mercy of the strong, is, no doubt, their feeling that the danger of such a smash as that at Hodges is remote. Possibly it is remote enough to warrant the practice, financially. When reasonable provision shall have been made against collisions, this danger will perhaps be made remote enough to make the passengers, as well as the stockholders, satisfied to have weak cars continued in service; but if the present state of the public mind continues, the legislatures may be expected to take action looking to a remedy.

PER DIEM.

The great reform in settlements for interchange car service which was begun three years ago and which was put into operation a little later (July 1, 1902), is now a settled feature of American railroad practice, and may be regarded as irrevocable. The best man to review the history of the past two years in this field is Mr. Arthur Hale, chairman of the American Railway Association Committee that has been the guide of the railroads in making the change, and an article from him will be found in another column of this paper. Like some things that have been done in "world politics" in the last half dozen years, this grand movement, which can hardly be compared with anything smaller than National government affairs, is not without its dark features and unsettled problems; but the main results—that freight cars have been made more useful and that creditors and debtors can deal with each other rationally, and not be constantly in the dark—are accomplished. Even an expert, after all these months of experience, has to say, as does Mr. Hale, that comparisons between mileage and per diem are difficult to make; but the present general satisfaction is, fortunately, so well founded that its permanence does not depend on any comparison with the past.

Of course, Mr. Hale does not try to settle the thousand local or semi-local problems which burden the mind of the manager of an individual railroad, nor make any predictions for the future; but the records entertainingly a number of significant conclusions on the general subject. One of the most definite of these is that the short terminal roads have been proved able to stand a twenty-cent rate; to pay 20 cents a day for cars which formerly they got for 6 cents a day, more or less. There is no need to try to calculate how this has been brought about. Whether the road moves cars with less delay, or gets a larger share of the revenue on the freight, or stands a small loss, is immaterial from the outsider's point of view; the main thing is that enough roads have lived through the ordeal to insure the success of the whole broad scheme. All are agreed that, from an association standpoint, a per diem rate is right and a mileage rate is wrong; and that is enough to outweigh a great deal of local or temporary loss, or even injustice. Abstract right does have some weight now and then, even in business.

Of the grievances which do or may affect all alike, the most serious is the facility with which unprincipled managers can "break penalty" by moving a car on to another road to avoid paying 80 cents a day additional for unreasonably delaying it. Such second road is practically a confederate in a conspiracy, though unintentionally. While this may not be a serious question financially, it is an important one practically, for, like the suspicion of error or cheating under the mileage plan, it is always available as an argument to stir up discord. The only remedy in sight is to make a higher ordinary rate and abolish the penalty entirely. Whether this will ever be done remains to be seen. The penalty rule is a constant reminder that owners desire to have their cars at home; its abandonment, whatever the process by which that is accomplished, or whatever may be put in its place, will seem to indicate that that desire no longer exists; or at least will often be taken to so indicate when money can be made by adopting such view. Those car-service men who advocate pooling the ownership of freight cars, or the indiscriminate use of all cars on all roads, as the Pullman Company uses its sleeping cars, when necessary, would, presumably, be glad to see such a weakening of the home idea in car service. But whether the management of the freight cars of the country—or even a large section of the country—could be satisfactorily carried out by a clearing house is a point on which these advocates have not yet thrown much light. A million freight cars, used for a hundred kinds of traffic, would put

up to their manager a problem quite different from that involved in distributing two or three thousand sleeping cars, used for a single kind of traffic. Probably the whole question of penalty will have to wait until enough experience has been accumulated to give more courage to the men who advocate raising the 20-cent rate on general grounds, regardless of the penalty principle.

One difficulty, more troublesome than "breaking penalty," is hardly touched on by Mr. Hale; the attitude of the roads which have not joined in the per diem agreement and stick to the mileage plan. These roads are short and in some cases nothing more than switching roads; but they are sure that the adoption of per diem would increase their expenses, and so they persistently stick to their old methods. Unfortunately, the railroads most directly interested usually seem to think that it is for their interest to yield to these shipper-railroads, and uneconomical practice therefore continues. If the owner of the switching road be a big shipper he gets the better of the railroad in the same way that the "beef trust" is understood to vanquish the railroads in the matter of refrigerator cars. A high rate paid to the car owner by the railroad takes the place of a low freight rate on goods transported by the railroad. The short-railroad evil is not exactly the same as the private-car evil, but about the same remedy is needed. There is more need of applying a remedy, because the private-car evil sometimes is not an evil; sometimes it is good economy for a railroad to hire cars from a car company at a high price rather than build or buy cars for a service more or less temporary. But in both cases the per diem principle, if adopted, promotes good service, and therefore it ought to be applied. Moreover, a per diem rate comes much nearer to being just, in the abstract, than does a mileage rate.

As car-service rates, whether mileage or per diem, are largely arbitrary, it takes a powerful body to effect any change, and therefore association action is necessary. The larger roads two years ago used some coercion, or something very like it, in getting certain important railroads into the per diem agreement; and it looks as though they could do a public service now by exercising similar influence on some roads which are not important, measured by length, but which are important measured by their power to hinder the progress of a needed reform. For all practical purposes the argument is the same as when dealing with railroads proper; the per diem principle promotes economical use of cars and can be made to insure honest and accurate payments. Any injustice done to any road in the adjustment of the car service rate can and should be made up for by an adjustment in the rates for transportation.

In this connection it is to be observed that the enforcement of reasonable demurrage on freight cars detained to load or unload is a part of the same problem. The only thing necessary to insure the best practicable conduct of the demurrage matter would seem to be united action on the part of the railroads. Every few weeks the newspapers report a new decision from some court, upholding demurrage regulations; but no new law is thereby made; the successive decisions only repeat what has already been declared by other courts. It is good to have this reinforcement of just laws, but what is needed is not more decisions but more decision—on the part of the railroads. It would perhaps be pleasant if the courts could be called upon to do all of our unpleasant jobs for us; and still pleasanter if we could have statute laws compelling obstinate railroads to adopt enlightened methods. When two short railroads almost side by side, and doing business under almost identical conditions, take opposite positions, one adopting rational methods and the other keeping its attention fixed on a single page of its ledger, the temptation is strong to call for legislative regulation. But State legislatures oftener do harm than good in railroad management, and this matter of car regulation is one in which the railroads are peculiarly well situated to cure their own ills, if only they will act with vigor. It is cause for congratulation that we have available so effective a law-making body as the American Railway Association—albeit the Association makes no laws at all. A body which, like this, has only recommendatory power, even over its own constituents, ought, in a matter of this kind, to be just as useful and effective as the most powerful government in the world; for a recommendation depends for its force on its reasonableness; and the reasonableness of per diem for interchange, and of demurrage for detention, is universally acknowledged.

An important western road recently undertook to build a large passenger car yard in connection with some extensive changes in one of its terminal stations. Before the plans were made a large number of existing yards in different parts of the country were inspected and studied in the hope of adopting their good features. The results of the investigations were disappointing, and in the end much original work had to be done in planning facilities in order to provide for present needs and prepare for further improvements in the future. Two prominent features were especially observed in the yards inspected. These were the facilities for making running repairs to cars and the arrangement of air, water and steam piping. In most of the yards the steam piping was carelessly laid and poorly protected. Apparently little thought had been given to economizing steam in heating the standing coaches; though it is quite likely that under similar circumstances steam pipes for supplying an engine situated at some distance from the boiler house would have been carefully protected to prevent waste. At first thought, the expense of a concrete-lined pipe-trench running through the coach yard might seem unwarranted, but it would probably pay for itself in one or two seasons out of the saving in coal alone, not to mention the other advantages of ease of repairs, good drainage, and general convenience. The amount of repairs made to cars standing in the coach yard depends largely, of course, on the remoteness of the car shops from the yard, though even where shops are close at hand there is always a certain amount of repair work that should properly be done in the yard, just as there is with locomotives standing in roundhouses, and a few simple facilities in the coach yard would relieve the shop of much work. The most important of these facilities is a drop pit for removing wheels from trucks. A convenient and inexpensive adjunct to the coach yard, especially in the northern States, is a "thawing-out" house. To thaw out the steam and water pipes in frozen cars by turning steam or hot water into them is tedious and wasteful; but if the whole car is run into an enclosed shed which is kept at a high temperature the pipes can be cleared with little expenditure of time or money. At all important points a 60-ft. turntable is a valuable addition to the coach yard. At such points there are always a number of observation cars, private and dining cars, etc., which must be turned, and, unless there is a convenient Y, it is necessary to use the roundhouse turn-table, which is usually kept busy by the engines; and delays and inconvenience are caused to both departments.

If the stock market is a reliable barometer, as it often is if we do not take our readings too often, the business outlook has now been encouraging for some weeks; and confirmation of this is found in the business world in a number of different directions. The improvement of the past few months has not been so great as the similar change in 1902, but it appears to be substantial. Railroad earnings have increased as a whole, so that for the month of August we find fair gains over August of last year. The demand for cars and engines has also improved, and in the last week orders have been given for about 10,000 cars of various kinds. This does not include a large number of cars which are being built by the Pennsylvania, the Louisville & Nashville, the Nashville, Chattanooga & St. Louis, and the Central of New Jersey at their own shops. The severe retrenchment ordered on some railroads has also been somewhat modified in consequence of the large gains in receipts and the better prospects. Work has been begun or is about to be begun on several extensive improvements, including the Pennsylvania tunnel and terminal at New York, the Baltimore & Ohio improvements at Cleveland, the Pan Handle grade crossing abolition in Cincinnati, and the Wilmington improvements of the Philadelphia, Baltimore & Washington, which were stopped last year, half completed. Orders for rails, although mostly small, owing to the uncertainty as to the prices for 1905, show a good aggregate, and include an order from the Baltimore & Ohio for 14,000 tons, and several orders of quantities ranging between 2,000 and 3,000 tons from Chicago electric roads. Government contracts have helped the business improvement. The navy department, as announced in these columns a few weeks ago, is about to let contracts for one battleship and two armored cruisers and is also ordering important work on a number of large arsenals. Orders were given last week for five large new lake vessels, making a total of nine ordered, for which upwards of 30,000 tons of steel plates will be necessary. The United States Steel Corporation has also announced its intention of building four or five large vessels. All these instances of improved trade, coupled with the promising corn and cotton crops, with only a moderate loss in wheat, would seem to indicate that fair progress is being made towards satisfactory conditions.

Education for the "Business" Side of Railroading.

The Philadelphia scheme for educating railroad men in a school of commerce—in vulgar parlance a "business college"—which was given in this paper Sept. 30, page 386, is the most ambitious project of the kind that has yet appeared. But the Wharton school has a reputation for common sense and conservatism, and useful work of this kind can be done there if in any school. We should feel a trifle dubious about the success of an attempt to effectively enlighten the youthful mind in the "practice and principles of rate making" unless a year were allowed to intervene between the two halves of the subject; but in the bright lexicon of the business college there is no such word as fail, so there is no room here for the pessimist. It is a sign of sagacity, certainly, to put practice first and principles second. The man who prepared the course evidently knows a thing or two about rate making. As in the case of schools of journalism, the visits to business institutions—taking a look at real work—must in any event be of the utmost importance. Taking a hand at it would be better. It is hard to see how the railroad course can be of great value unless this part of the teaching is done in the most thorough and systematic manner. Random half-day excursions will never fill the bill.

What may be called the literary side of this business training—the language, geography, law and science—will, of course, give full value to every young man who devotes himself to it. The education of men for business has long been a mooted question, but there can be no two sides to it if a young man has the strength and energy necessary to succeed. There has been a disposition to consider the educated man and the business man of so distinctly different type that the attainments of the one do not make for the fitness of the other. But it is idle to maintain at this late day that education does not have its place in every calling of life. In many cases the best combination on which to compromise with the extreme "practical" advocate is for the boy to be first placed in business for a period of about two years so that he can learn something of practical work and accustom himself to its drudgery. The wider outlook of the school will then be romantic to him in its reaches and rich in its illuminating explanation of the things with which he has already had familiar contact. If such a theoretically perfect combination of the apprenticeship and the instruction is impossible the next best thing is the school course in which, toward the end, the outlook is widened by contact with real life as is proposed at the Wharton school.

Circumstances as well as talent largely control the drift of men's lives towards that place where they come to do their life's work. These circumstances are fortuitous more often than prearranged or foreseen, so that it is impossible to determine in advance those things for which a boy ought to fit himself. This fact largely modifies the advantage of a highly specialized training. But the other fact that anything well learned contributes to a facility in other things most indirectly related, largely compensates for the direct inapplicability of much that is learned. In general it is fairly safe to say that the specific mechanical facility for any work must be acquired in the performance of the work itself and cannot be acquired in any school satisfactorily. Hence the reason why the practical man is disposed to look with some distrust upon too much specialization in the school.

There is another side to this question which should not be ignored. If we grant that time spent in school work is well applied towards ultimate efficiency then it must be made to account for credit to the man who has spent his time in such preparation, when he comes to compete with the man who has not spent any time in such a way. The things that he has learned are largely beyond the range of the work to which he will be immediately assigned, and this will continue to be the case for his first year or two. If his advance is held severely along the lines of those who do not have this larger ultimate fitness, he will be at a serious disadvantage.

This has discouraged many college graduates who have aspired to a railroad life, and they have gone elsewhere. We have no ready-made solution of this difficulty, but it needs to be solved, for there is no question that the railroads need educated men. It is a serious charge against railroad managers when a man of practical affairs and such eminence in his calling as President W. H. Baldwin, Jr., accounts for the small representation of college men in railroad employ on the ground that the railroad manager has not as yet arranged a plan for injecting the college man into the organization.

The interesting tables of various items of maintenance expenses given for ten successive years in the annual reports of the Illinois Central and of the Yazoo & Mississippi Valley Railroad show in a striking way how certain renewals fluctuate. Thus the Illinois Central used 34,614 tons of rails for renewals in 1899-1900, when it had about 6,000 miles of track, or 5.77 tons per mile of track; in the year ending with June last, with an average of 6,480 miles of track, it put in 24,037 tons of rails, or 3.67 tons per mile of track. On a railroad like this, with abundant earnings and the best of credit, there can be no question of postponing renewals too long. Last year rail renewals were less than 1 per cent. of the total working expenses. The figures for tie renewals show even greater fluctuations: 1,987,356 ties were used in 1901 (about 320 per mile of track); 1,086,693 (172 per mile of track) in 1903, and 1,563,898 (241 per mile of track) last year. Tie renewals have cost more than rail renewals in every year of the ten except 1903, and for the entire ten years 50 per cent. more ($4,990,006 for ties against $3,288,406 for rails). The Yazoo & Mississippi Valley report shows the cost of rail renewals to have varied from *a credit* of $831 in 1901 to an expenditure of $140,919 last year, when it was more than the aggregate for the eight years from 1895 to 1902. The credit we may suppose to be due to sales of old rails much in excess of the 105 tons of new ones put in the track in 1901. Tie renewals have varied from 292,242 last year to 493,360 in 1898, that is, from 249 to 610 per mile of road (not track). When the road was built there must have been timber enough on the right of way to tie the track several times over. The cost per tie of tie renewals was only 24 cents in 1895, 30 cents in 1900, and a trifle less than 40 cents last year—figures which most railroads will envy.

Louisville & Nashville.

Louisville & Nashville for the year closing June 30 reported a net income of $6,688,000, which amounts to 11.15 per cent. upon the stock, but the directors charged expenses with $1,746,000 of betterments. If we restore to income the amount thus deducted we have a total net income of $8,434,000, or 14.06 per cent. on the stock. Last year the corresponding earnings were 13.69 per cent., therefore the results of the year are slightly better than a year ago.

There has been added to the operated mileage during the year 199 miles, of which a length of 86 miles is owned, and 113 miles operated, but not owned. The principal extension is the line known as the Knoxville, La Follette & Jellico Railroad. This is designed to give the Louisville & Nashville a short line from Cincinnati to Atlanta. Its completion, soon expected, will give the Louisville & Nashville advantages which it has long needed in the territory east of the iron district of northern Alabama.

The operated mileage consists of a large number of separate financial entities bound together by ownership of stock or control of stock. In the past year the company has consolidated some of these properties with the parent company. The Alabama Mineral Railroad and the Birmingham Mineral Railroad have been merged in this way. Both these roads have heretofore been operated as part of the system, but were controlled through ownership of the entire issues of capital stock and first mortgage bonds. The company has also acquired the entire capital stock of the Newport & Cincinnati Bridge Co., and has taken for itself the full title to the property, and has bought the Southern division of the Cumberland & Ohio, which was sold under foreclosure. All these properties are or will be deeded to the Central Trust Co. as pledges under the unified mortgage. The financing of the year is indicated by the table below.

Debit:	
Increased liabilities—	
Funded debt	$9,055,179
Contingent list	3,254,000
Profit and loss	3,391,714
Decreased assets—	
Investments	6,528,319
Materials and supplies	1,818,556
Total	$24,047,768
Credit:	
Increased assets—	
Cost of road and real estate	$11,464,385
Advanced to subordinate companies	6,362,067
Sundry accounts	222,109
Current assets	4,010,973
Contingent assets	1,046,204
Decreased liabilities—	
Reserve accounts	15,288
Sundry accounts	926,742
Total	$24,047,768

The increase by sale of collateral trust bonds and unified bonds yielded over $9,000,000, and the assumption of the guarantee of interest on properties taken over added $3,254,000 more to the increase of liabilities. The change in the form of ownership from investments to property merged into the general property of the Louisville & Nashville accounts for the decreased investments of $6,528,000, and for an equivalent amount in the cost of road among the increases in assets. The increased advances to sub-companies are incidental to the construction now in progress. The income account is not unfavorable:

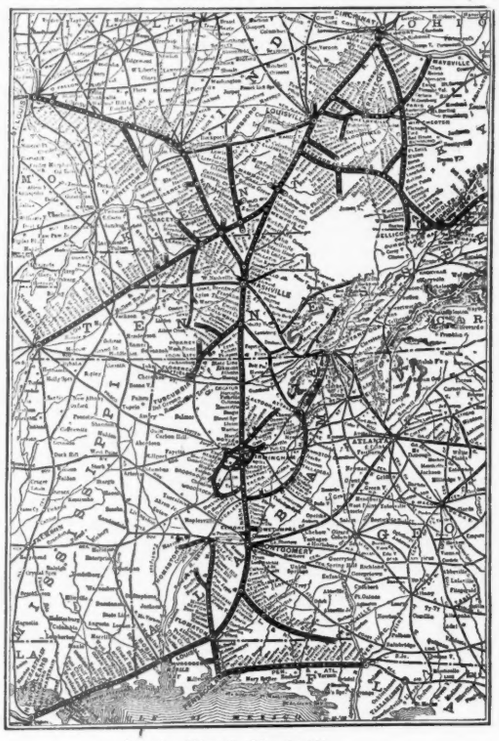
	1904.	1903.	Increase.
Earnings	$36,493,792	$35,449,377	$1,494,414
Expenses	25,141,548	23,970,812	1,170,735
Net earnings	$11,802,244	$11,478,565	$323,679
Other income	1,635,154	1,122,493	512,661
All income	$13,437,398	$12,601,058	$836,340
Charges	6,749,227	6,390,010	359,216
Net income	$6,688,171	$6,211,047	$477,123

The net result is an increase of about half a million dollars, due partly to the increase in earnings on L. & N. proper and part to the profitableness of the other properties owned. Half of the increase in direct earnings was from freight and half of the increase in returns from freight was due to the higher average rate, the other half being due to new business. The average receipt per ton mile increased from .779c. to .790c., or 1.41 per cent. Expenses increased $1,171,-

000. This increase was about equally divided between maintenance and transportation expense.

The report this year contains a detailed table of expenses which is a decided improvement over the crude exhibits formerly given; but no comparisons are made with last year's operations. It is noticeable though at the outset that conducting transportation expense is not a large proportion of earnings, being only about 35 per cent. The increase for the year being only slightly over half a million, puts this among the few roads in which the increase of the transportation expense of the year is not all out of proportion to the increase in earnings.

The property evidently was well maintained; the betterment expenditures charged to earnings, amounted to $1,746,000 compared with $2,000,000 last year. Not a serious decrease. Over one-third of the total expenditure for improvements was for equipment and over $300,000 of it for sidings, while the remainder was principally spent for buildings, heavier rails and stronger bridges. The notable thing in operations this year is the shifting of the balance for car service from a debit balance of over $100,000 to a credit balance of $12,000. The aggregate saving is not large, but the significance of these figures is notable, reflecting as they do the increase in equipment and better disposition of cars, due no doubt largely to the influence of the reform in method of payment.



Louisville & Nashville.

The balance of traffic was well maintained, the local mileage being 68 per cent. of the whole, though this was slightly less than last year. The average train load has been pushed up from 180 to 185 tons, or nearly 3 per cent. By the purchase of the new equipment the first of the year, the rolling stock is apparently in very good condition. Of the locomotive equipment, 10 per cent. was bought within a year, nearly 7 per cent. of the passenger equipment and 12 per cent. of the freight equipment. Freight traffic cannot be examined as no tonnage tables are given. On the whole the report tells of a year of successful operation with no large expansion in the traffic or the operations. The new line which is in course of construction is not yet a considerable factor in the business of the road. Louisville & Nashville has a safe reserve in the standard of maintenance and in the physical condition of the property and equipment. Conservatism is plainly impressed upon every feature of the report.

Chicago & Alton.

The fourth annual report of the Alton shows the same characteristic development of traffic which has been evident in the operations of the property since it was acquired by the "Harriman interest" in 1900. This growth in traffic is best illustrated by the following table comparing the gross receipts and the gross receipts per mile of road for the past six years.

	Receipts.	
	Gross.	Per mile of road.
1899	$6,546,590	$7,766
1900	7,796,450	9,119
1901	9,036,656	9,826
1902	9,225,739	10,032
1903	10,071,092	11,002
1904	11,425,853	12,484

The table shows an increase of about 75 per cent. in gross receipts and of 65 per cent. in gross receipts per mile of road since the reorganization in 1900. The company has built but little new road. The ton mileage increased .4 per cent. and the freight train mileage 6 per cent.; but the average receipt per ton mile increased 13 per cent., making the earnings per freight train-mile a little over 6 per cent. better. Passenger earnings per passenger train-mile increased over 15 per cent.

The report is not as complete as could be desired. The statement of improvement work does not show what work is charged to capital account or what to income account. Expenditures for betterments and equipment during the year amounted to $697,893 as compared with $1,879,410 in 1903. Of this, $595,904 was for improvements on roadbed and structures, as against $1,636,465 expended for the same purpose last year.

Gross earnings from all sources amounted to $11,425,853, as against $10,071,092 last year. Freight earnings contributed $7,445,877, an increase of $835,240. It is in live stock, grain, flour and mill products that the chief traffic gains of the year are found, the increase in flour and mill products amounting to 85 per cent. over last year and the gain in live stock to nearly $200,000, or 40 per cent. more. Receipts from passenger traffic amounted to $3,351,943, an increase of $443,360, or 15 per cent., and passenger receipts are now equal to nearly 50 per cent. of the freight. Ninety per cent. of the passenger traffic is classed as local.

Operating expenses for the year were $7,524,600, or $899,404 more than last year, leaving a gain in net earnings for the year of $454,357. Maintenance of way charges increased $232,645 and conducting transportation increased $576,664, heavy renewals of rails having been made. During the past five years ties and rails have been renewed on over 60 per cent. of the track, and renewals of ballast during the same period average about 35 per cent. Maintenance of equipment charges remained about the same, as in 1903, increasing only $39,930. During the year 17 locomotives and 50 passenger coaches were added to the equipment. In the past five years, the total tractive power of the locomotives in service has been increased from 2,874,520 lbs. to 5,460,445 lbs., or 89.9 per cent. At the same time, the average capacity per freight car has increased from 21.52 tons to 31.72 tons.

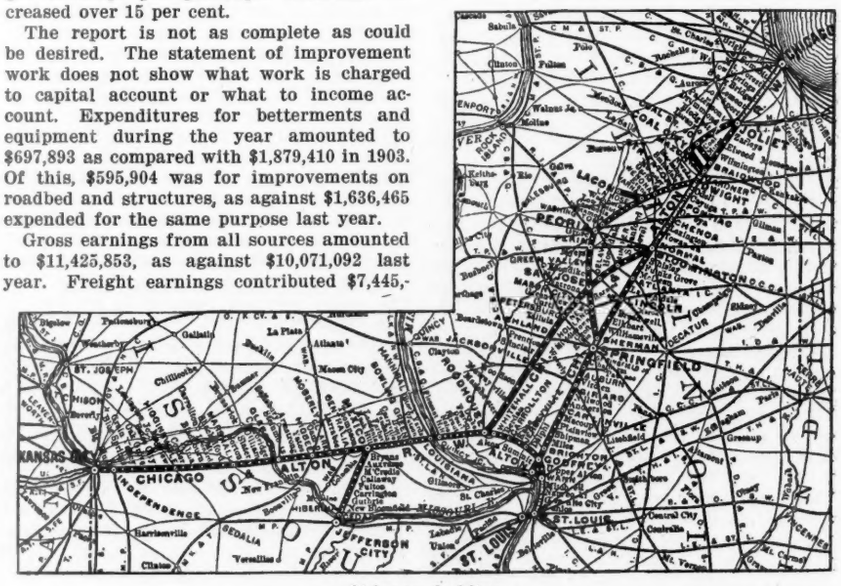
The more important statistics of operation follow:

	1904.	1903.
Average mileage worked	915.2	915.4
Gross earnings	$11,425,853	$10,071,092
Freight earnings	7,445,877	6,610,637
Passenger earnings	3,351,943	2,908,583
Mail	259,899	241,112
Express	253,921	218,039
Operating expenses	7,524,600	6,625,196
Maint.-of-way	1,446,010	1,213,365
Maint. of equipment	1,230,762	1,190,832
Conducting transportat'n	4,559,731	3,983,068
General expenses	288,094	237,931
Net earnings	3,901,253	3,445,897
Net income	3,561,253	3,100,897
Surplus, June 30	693,346	569,438

NEW PUBLICATIONS.

Mechanical Railway Signaling. By H. Raynar Wilson. London: Published by *The Railway Engineer*, 3 Ludgate Circus Buildings. Price 18 shillings, net.

The first edition of this work was issued four years ago and was noticed in the *Railroad Gazette* of Oct. 5, 1900; and now the publisher has issued a second edition. It is an elaborate work of 200 pages, describing in much detail the principal kinds of mechanical (manual) interlocking machines in use in England. A considerable number of new illustrations have been added and the index has been amplified. Mr. Wilson, who some years since dissolved his connection with the Lancashire & Yorkshire Railway, has written a book on "Power Railway Signaling," which, it is announced, will be pub-



Chicago & Alton.

lished at an early day; and to this new work has been transferred some of the matter from the older book on electric train staffs and tablets for single track working. This forthcoming book describes controlled manual and automatic block signaling, and pneumatic interlocking.

State Demurrage Rules; by John B. Daish. Published by *Grain Dealers Journal*, Chicago. Price $1.

This is a reprint, evidently made by a careful lawyer, of the laws relating to demurrage on freight cars in the States of Connecticut, Florida, Georgia, Louisiana, Minnesota, Mississippi, Missouri, North Carolina, North Dakota, South Carolina, Texas and Virginia. Following the laws themselves is a digest showing in tabular form the main features of the laws in each State. For example, the free time in Connecticut is four days; in one State 72 hours; in eight States 48 hours; in one State the time allowed on grain is only 24 hours; one State does not specify the free time.

Loci in Mechanical Drawing. Part III. Piston Acceleration, by Alex. MacLay. The Technical Publishing Company, Limited, Manchester, England. (D. Van Nostrand Co., New York). 120 pages, 5 in. x 8 in. Cloth. Price 2s. 6d.

The aim of this book is to introduce to the student a class of loci which are neither geometrical nor mechanical. Curves of velocity and acceleration are discussed and worked out in connection with examples of piston motion in engine mechanisms of the slider crank order. The book is especially valuable inasmuch as it embodies a number of notes which heretofore have not been available to students of this subject.

TRADE CATALOGUES.

The Buckeye Jack Manufacturing Co., Louisville, Ohio, has issued a new catalogue, its third. The first pages show the four different styles of jacks that the company has been making since its establishment in 1902. The construction is fully described, and views of the assembled jack and of the detail parts shown; also the chief characteristics of each style are enumerated. Three new jacks have been added to the previous line, and four more styles are to be added in a very short time. The three new jacks are described and illustrated in the same manner as those preceding. For the four styles soon to be added, the capacities and the purposes to which they are adapted are given. On the last two pages are printed a number of testimonials relative to "Buckeye" jacks.

The Under-Feed Stoker Company of America.—The September number of "The Publicity Magazine," published by this company in the interests of the Jones stoker, contains a number of half-tone illustrations of boiler rooms in which these stokers have been installed as well as a number of interesting facts in regard to stoker equipments. A table of standard steam boiler measurements is given, and the results of a boiler trial made at the University of Chicago are also shown. The boiler in this trial was equipped with a Jones stoker. Aside from its mechanical features the magazine contains a considerable amount of light reading.

The Crocker-Wheeler Company, Ampere, N. J., sends a pamphlet bearing the title "Railway Generators at the Louisiana Purchase Exposition." It contains illustrations and descriptions of the engines and generators used in the Intramural power plant. This plant consists of six steam-driven units, each driven by a different make of engine, and one generator driven by a water-wheel. The capacities of the generators range from 100 k.w. to 900 k.w. They are of the Crocker-Wheeler standard railway type and are compound wound for 550 volts.

The Rand Drill Company, New York, issues its circular No. 14. It contains illustrations of the latest pneumatic hand tools such as are used for chipping, calking, flue beading, riveting, drilling, etc. Short descriptions and tables showing the capacities of the tools are given, as well as a number of half-tone illustrations which show the tools in actual use. These photographs cannot help but impress one with the wide range of usefulness of the pneumatic hand tool.

Bulletin No. 171 of the American Blower Company, Detroit, Mich., describes its newest engine, Type A, which is a vertical, enclosed self-oiling design. Considerable space is given to the method of lubrication, which is illustrated by a phantom perspective, and the details of which are fully illustrated and carefully described. Other details are also described, and illustrations of the most important parts shown.

The Niles-Bement-Pond Company, New York, is distributing its September number of the Progress Reporter. A full detailed description and illustrations of the improved Pond car wheel lathe are given, as well as a short article which gives in detail the method of operation recommended for attaining the highest rate of production. The company claims that with this lathe an average of six pairs of car wheels can be turned out in 10 hours.

Joseph T. Ryerson & Son, Chicago, Ill., issue a booklet bearing the title The Path the Calf Made. The tale is in verse and tells about the historic calf, wabbly of legs, which left a crooked trail, which became a path, a lane, and finally, after many years, a city street. The moral is applied to flue welding; the only straight road is by way of the Ferguson flue-welding machine, which is described and illustrated.

The Richmond Electric Company, Richmond, Virginia, maker of electrical machinery, is distributing its bulletin No. 3. It contains a full detailed description and illustrations of the R. E. type direct-current generators. These generators are made in 18 sizes varying from 0.75 k.w. to 37½ k.w. A table shown in connection with a diagram gives the dimensions and weights of the machines.

Dean Bros. Steam Pump Works, Indianapolis, Ind., is distributing an interesting booklet descriptive of its condensing machinery. It opens with a short, but comprehensive article, which explains the duties of the air pump and condenser. This is followed by detailed descriptions and line and half-tone illustrations of different types of air-pumps, jet and surface condensers, cooling towers, etc.

Chapman Valve Manufacturing Company, Indian Orchard, Mass., issues a pamphlet containing a partial list of customers who use its valves for high and low-pressure and superheated steam service. This company makes valves from ¼ in. to 72 in. in diameter, operated by hand, air, electric, or hydraulic power. Line and half-tone illustrations of various types of valves are shown.

Something Pneumatic, or the September number of the monthly magazine of the Chicago Pneumatic Tool Company, contains the usual number of interesting articles on pneumatic devices and their applications; also a reprint of a paper on "River Wells and Horizontal Delivery of Water," read by C. H. Friederick before the Ohio Society of Mechanical, Electrical and Steam Engineers.

The Crane Company, Chicago, Ill., sends a leaflet descriptive of its renewable seat and disk, globe and angle valves, and of its renewable seats and wedge, straight-way valve, for high pressure service. Illustrations, sizes and prices of the valves are given. The company is also distributing an illustrated pamphlet descriptive of its exhibit at the St. Louis Exposition.

The Obermayer Bulletin for October, published by The S. Obermayer Company, is designed primarily to show the various goods made by that company and their adaptability to foundry practice. There is also an article on "Brass Melting," and other articles on new foundry materials that have previously not been advertised.

The Little Blue Flag, a magazine published by The Lowe Brothers Company, Dayton, Ohio, contains in the September number a statement regarding the outlook for fall business, which it pronounces most encouraging. There are also other articles of interest to paint sellers and paint users, and some good advice for both.

The Garvin Machine Company, New York, issues a pamphlet in which brief descriptions and illustrations of about 135 modern special machine tools are given. This is being distributed among the various manufacturing companies with a view of interesting them in an economic method of making duplicate machine parts.

CONTRIBUTIONS

Multiple Unit Control for the Subway Cars.

The new cars for the Interborough Rapid Transit Company to be used in the New York Subway are equipped with the Sprague-General Electric system of multiple unit control. It was erroneously stated in the article on "Power Equipment for the New York Subway" in the *Railroad Gazette*, September 16, that these cars were equipped with the Westinghouse electro-pneumatic system of control.

Unions vs. Individual Progress.

TO THE EDITOR OF THE RAILROAD GAZETTE:

The editorial on "Unions vs. Individual Progress" in your issue of September 2 and the comment of G. S. M. in your issue of September 9 suggest some other reasons for the apparent lack of interest taken in the welfare of the railroad companies by the employees in the train service.

Should an engineer running a "pooled"

engine be expected to make repairs? Charles Paine in his "Elements of Railroading" pointed out the economy of "pooling" engines and the resulting competition among the enginemen, the fair apportionment of labor and the readiness of any engine or any crew for an emergency. The old idea that an engineman was wedded to one particular engine for life has been superseded by the modern ideas of getting all possible work out of an engine all the time and thus to save the investment of large amounts of capital. Few if any railroad officers will support the old argument that the sentimental regard of the engineer for his own pet engine will keep it in more perfect condition than could be attained in any other way. This is not an age of sentiment.

Many roads are practicing strict economies in doling out oil, coal, waste and other engine supplies, and it improves an engineman's record to use just as little of these as possible, regardless of the damage to bearings or failure to make steam and the consequent delays on the road. As for the train crews the one sin which they can commit is to run behind schedule time. Cars are coupled with more certainty when they are run together hard and time in switching is saved at the expense of damage to rolling stock. The train crews are urged on by the operating department and the motive power department repairs the damage. If a record was kept of O. S. & D. freight charged against the train crews and a car damage record was kept against the engineer and conductors, together with a record of delays to trains due to hot bearings, possibly it would point out ways of curing some of the most pernicious practices of present day railroading.

OBSERVER.

Comments on the Per Diem Rules.

BY ARTHUR HALE.

1.—"The rate for the use of freight cars shall be twenty cents per car per day, which shall be paid for every calendar day, and shall be known as the per diem rate."

This rate was the result of a series of compromises and was attacked before its adoption by the advocates both of higher and lower rates. The high rate men claimed, with justice, that 20 cents a day does not represent the worth of a modern freight car, or even its cost to the owners. The low rate men claimed it would increase their payments for car hire so materially as to amount to a confiscation of their net earnings. These two arguments practically neutralized each other. Under the mileage system car owners were getting about 12 cents a day for their cars, so that the new rate gave them an increase of over 60 per cent. More than this would have been an undue hardship to the railroads which had been encouraged during the existence of the mileage system to increase their business by the use of foreign cars. It has been proved that these railroads can stand the 20 cent rate. Whether they could have stood a higher rate at the beginning is a question. Some of the railroads which were anxious for a high rate have found that 20 cents was high enough to begin with, but there is still a persistent demand from certain influential railroads for a 30 cent rate.

It is very difficult to make a lucid comparison of performance under the per diem and the mileage system, but it is perfectly clear that 20 cents represents 33 miles at six mills, and there are a great many railroads that do not make 33 miles a day with foreign cars. Such roads are paying more than they used to pay for such foreign cars. Most of them make this up from increased receipts for their own cars on foreign roads, but some do not, and such roads are not anxious for an increase. There are other roads which have made a general improvement in their methods of distributing and handling cars and thus have increased their mileage per day enough to warrant their joining the ranks of the high-rate railroads.

2.—"Days shall be reckoned by subtracting the date of receipt from the date of delivery. The day of receipt shall be disregarded and payment made for the day of delivery."

This rule, like Rule 1, follows very closely the language of what we may call the original per diem rules, which were formulated by the trunk lines during the per diem experiment of 1888. These original rules were adopted by the Committee on Car Service of the American Railway Association and were reported by the committee to the association with slightly varying language a number of times between 1888 and 1901.

At the autumn meeting of the association in the latter year, these rules were taken from the table of the association and referred back to the committee with instructions to report an elaborated set of per diem rules. This action was taken without opposition and put the committee, at the next meeting, at a great advantage over the opponents of per diem.

A few words are added to the original rule, making it perfectly clear that a road which holds a car at 12.01 a.m. of any day, is responsible for the per diem for that day. As a result, there is no confusion in closing the per diem accounts of one month and opening those of another month.

When the system was first adopted there was a good deal of loss to car owners at interchange points where there was no man in charge at night. At such points the delivering road invariably claimed delivery as of the evening before, and the receiving road claimed receipt as of the morning after, and between the two roads there was a difference of one day in their per diem accounts. By systematic checking on the part of car owners, such differences are gradually becoming eliminated. This may be a good place to say that many railroads are employing more clerks to check up the per diem on their own cars on foreign lines than they do to check up the per diem made by foreign cars on their own lines, finding that the cost of such checking is amply repaid by corrections in the car accounts of their neighbors. This checking of another road's accounts is something that has only been possible since the adoption of the per diem system. If the per diem accounts, which can be checked, are so inaccurate, what must have been the inaccuracy of the accounts under the mileage system, which could not be checked?

3.—"A road shall have the right to demand the return of its car after it has been twenty days consecutively on any road. If the car is held by that road more than ten days after date of such notice on the prescribed form (L), making thirty days in all, thereafter a penalty rate of 80 cents per day in addition to the per diem rate, shall be paid by such road for the further use of that car."

This rule was new when originally adopted by the A. R. A. in the spring of 1902, and like all new rules it has caused some trouble. There have been a good many attempts to repeal it, chiefly in connection with the proposed increase in rate, as noted above. In general the short roads prefer a low rate and penalty and the long roads prefer a high rate and no penalty. It was at first urged that the penalty rate should apply automatically after a car had been on a foreign road more than 30 days, but there seems to be a general acquiescence in the present plan, especially since the adoption by the American Railway Association of a prescribed form for penalty notices and a method of transmitting them.

At present the chief difficulty in connection with the penalty rule is what appears to be its evasion in certain quarters. These evasions are thought to occur, first where two or more roads are under one General Manager, and it is in the power of their general officers to move foreign cars back and forth between these roads forming the same system, breaking penalty with such interchange. Second, when cars are interchanged between a per diem and a non-per diem road. In such cases the per diem road is usually responsible for the per diem rate, while the cars are on the non-per diem road, but it is not responsible for a continuous penalty.

These cases would not appear so aggravating if it were not for the fact that many industrial roads, which in the eye of the car owner would appear to have no standing as railroads at all, are considered by their connections as genuine railroads, even though they do not pay per diem. The American Railway Association has not taken final action on any of these questions, the feeling being that it would be better to allow the situation to develop rather than to take a step in the dark. The indications are, however, that a serious effort will be made at the next meeting to draw a line which will exclude from the per diem rules agreement many of the so-called "industrial roads," putting them in the category of "sidings." When this question is settled, there should be a general acquiescence in a rule whereby interchanges between a per diem road and a non-per diem road will not break penalty.

The question of divided systems is complicated by the fact that many of these systems were divided for accounting purposes long before the per diem system was adopted. It hardly seems fair to give any one man such power over foreign cars that he can move them indefinitely between different portions of one system, so as to be able to forever avoid the payment of penalty.

4.—"All railroads, including ferry lines, shall be responsible to the car owner for amounts accruing for the use of a car at the established rates, whether such a car is in road service or in switching service, until the car has been delivered to the owner or to another road."

This is one of the old rules with slightly changed language, a very important rule at first and now considered as an absolute matter of course. Under the mileage system no mileage was paid on cars in switching service, either on belt or trunk lines, and no mileage was paid on cars ferried long distances; and if the road holding the car was so arbitrary as to make no report as to whether or not the car was in switching service, this arrangement subjected the mileage accounts of many railroads to a suspicion which it is to be hoped was unjust.

As noted under Rule No. 2, it has proved practicable to check per diem, and all such suspicions are disappearing rapidly.

5.—"An arbitrary amount for each car in switching service may be reclaimed by the switching line from the road for which the service was performed. This amount shall be based on the average number of days actually required, and be determined by the roads directly interested for each local territory."

This was another new rule designed to make it practicable for the belt railroads to enter the per diem agreement. While the rules were in process of formation, the traffic departments of a number of railroads were consulted as to the practicability of so

increasing the switching rates as to make it possible for the switching roads to enter the per diem agreement without further provision for their relief. That something had to be done was evident, for in a number of cases the net earnings per car per day of the switching roads was less than the per diem rate proposed.

The traffic officials so consulted decided that as, in many States, the maximum switching rate was prescribed by law, and as at other points the switching tariffs were the gradual result of many years' experience and involved many interests, it would be impracticable to make any general change. A very difficult problem was therefore presented to the committee, and as a solution they presented the association the present Rule 5, which has so far stood without change. It is a very elastic rule and is based centrally on the idea that adjustments of switching rates in so vast a territory as North America must be settled by local bodies. The only restriction, therefore, that the association prescribed, was that the rate of reclaim should be arbitrary, this being the only evident method by which the per diem incentive for prompt movement of cars could be maintained.

Upon the passage of these rules, the railroads of the country promptly responded and meetings of transportation men were held in June, 1902, at which rules were formulated covering these switching reclaims at practically all points in the country. The first set of rules was formulated at St. Louis, which prescribed a reclaim amounting to the per diem paid on a certain number of days, which was supposed to represent the average for the round trip of a car in terminal switching service, while a smaller amount was prescribed for cars switched between one railroad and another without loading and unloading.

There has been singularly little change in the agreements so made. At Chicago the rate has been shifted up and down, and at certain other points experiments have been made and are making with a basis of the actual time consumed by each car in switching, with a maximum allowance; but in general, the original rules have stood very well.

The only point on which there has been any general change is on what has been called "Double Reclaim." Under the original rules the same allowance was made on cars switched either for loading or unloading as was made for cars loaded both ways. Now, cars loaded both ways in switching service take more time and involve the payment of more per diem, and it is gradually becoming understood and accepted as a principle that it is better to make a lower rate of reclaim and apply it on every loaded movement of a car in switching service, than it is to make exactly the same allowance on cars loaded one way and on cars loaded both ways. Considering the fact that this was practically a new question to the transportation men in the country—for switching rates have always been considered a traffic question—it is very gratifying that the question was solved so fully and so promptly.

> 6.—"In case a road delivers an empty foreign car without the consent of the owner to a road which does not pay per diem; or, if a road permits the loading or reconsignment of a foreign car, without the consent of the owner, to such a road, it shall be responsible to the owner for the payment of an amount equal to the per diem accruing on the car while on such road."

This rule, which holds a trunk line responsible for the per diem of a car on its connection, is a new rule. It probably did more to make the per diem system a success than almost any other. By Rule 5 it is made practicable for the belt lines and terminal railroads to enter the per diem agreement without undue loss, and by this rule it is made very much to the interest of the trunk lines to have the belt lines, terminal railroads and other small railroads with which they connect, sign the per diem rules agreement.

As noted under Rule 3, the pressure of the trunk lines to get some of the smaller railroads into the agreement has been so great that some of them appear to have pushed in so-called "industrial roads," which had never been counted as railroads at all. To this extent, the rule may be said to have worked too well, but this is something which can be readily adjusted, once the facts are ascertained.

> 7.—"When home route cards have been requested under the Master Car Builders' Rules, the per diem shall cease from date of request to owner. When a car has been destroyed and reported under Master Car Builders' Rules, the per diem shall cease from the date of notice to owner."
>
> 8.—"When a car is detained awaiting the receipt of repair material from its owner, the per diem shall cease from the date the necessary material is ordered from the owner until the date on which it is received by the road holding the car."

These rules have worked fairly well. They are designed to protect the owner of a foreign car against undue delay in shops and at the same time protect the road repairing the car against any delay caused by antiquated car design. There has been some difficulty in checking up the performance under the rules on roads where the motive power and the transportation departments were not close together, but this is something which usually has worked itself out.

An effort has been made to change Rule 8 so that when the owner was obliged to supply the repair parts, the per diem would not begin until these parts had actually reached the shop where they were needed, but it was recognized that the railroad where the shops were located was responsible for the movement from junction point to the shop. The rule was therefore allowed to stand.

> 9.—"The interchange reports shall close at midnight and shall include all cars interchanged upon the date named, unless otherwise noted thereon. The reports must be sent to the Car Record office each day, whether cars are exchanged or not. In cases where there are different standards of time at junction points, the time of the more easterly reckoning shall be used. The interchange reports to the Car Record office from junction points must be signed by the agents or other authorized representatives of both roads on the prescribed form, the receipt of cars delivered being thereby acknowledged. Car service rule No. 5 governs the delivery of cars. The time of delivery of cars upon interchange tracks of connecting lines shall *prima facie* be the time given by the delivering road."

This rule and car service Rule 5 are with some slight changes the original rules of 1888. It is to be noted that the last sentence of Rule No. 9 is practically the only change made by the association when it adopted the original rules as presented by the committee in the spring of 1902, and this change was proposed by the leading opponent of the per diem system. It is a very good provision, has worked very well, and has assisted greatly in the checking of per diem reports mentioned under Rule No. 2.

(*To be concluded next week.*)

Overtime of Freight Trainmen.*

I do not find that our men are at all inclined to loaf or drag with their work to make overtime. A little education and caution, together with frequent words of approbation for good work, constitute a great incentive for men to do their best, and thereby put themselves in a position to ask favors now and then. If I find a trainman inclined to shirk, and showing a disposition not to aid in making time, I take him off his regular run and put him on the extra list for a while. This immediately sets him to thinking in the right direction. I am pleased to say, however, that I have seldom had occasion to do this.

When there is a rush of freight, a trainmaster must quickly anticipate what the volume of traffic is likely to call for in the way of train service, and make up additional crews accordingly, so that ample rest, say from six to eight hours, can be had at terminals. On some lines, when a rush of business sets in, delays on the road increase because trains are held for meeting. This leads to additional overtime. Under such conditions an advantage can be gained by reducing the load, so as to enable the engines to make a better run. With such treatment the engines can be got around for return trips in less time than if they are continually burdened with a drag of cars that can barely be kept in motion.

You ask what I mean by "excessive overtime." I mean cases where crews are on the road on a continuous trip of from 18 to 22 and 24 hours, making about as much overtime in hours as their regular trip time amounts to. I have been told, by men who have come west from eastern lines, that the larger part of their pay has been from overtime work. The only chance for sleep they had was on the road, when waiting on sidings or when held at blocked terminals.

A man (a fireman) came to my office one day last winter from a connecting road and applied for a position as brakeman; he was in his working clothes, and looked as though he had not been washed for 48 hours; and he said he had just quit the other line, as they wanted him to go out on an engine when he had just come in, and had been on the road without sleep, by doubling, for 42 hours; and he came near dropping asleep in the chair while he was telling me his experience.

There has been more than one wreck recorded in the past year caused by men who had been overworked being kept out on the road on excessive overtime hours, beyond all reason. These collision records are a sharp commentary on the course of the officials who allow such things to come to pass. In our State (Indiana) the Legislature has passed a law limiting the hours of labor of trainmen and enginemen to 16 hours, and requiring eight hours rest thereafter, excepting in emergencies such as wrecks and washouts. Our train despatchers are cautioned to look out for trains that have been badly delayed, and arrange for their proper movement by setting out cars, if necessary, so as to get them into a terminal within the prescribed time, if possible. Our freight conductors are also instructed to call the despatcher's attention to their situation when nearing the 16 hour limit, so that they may not be overlooked. Our men know that when they get in from a hard and long run they are sure of eight hours' rest.

We do not make allowance for rest that may be obtained in cabooses on the line, except, perhaps, in connection with circus trains or freights that are on sidings, waiting, perhaps, for a wreck to be cleared. Then we advise the men to go to sleep in the caboose, and we have them called by the station agent when wanted.

*Notes by a Trainmaster.

Some Notes on the Early History of the Hudson River Tunnel.*

BY S. D. V. BURR.

In the early work upon the tunnel two operations were marked by bold originality, and are at the present time of historical value, one as a disastrous failure and the other as a successful solution of a most difficult proposition. But neither will ever be attempted again by any engineer at all familiar with the history of tunneling or with modern methods of prosecuting underground work. Since both of these jobs were performed over 20 years ago it may be of interest to briefly recall the facts about each.

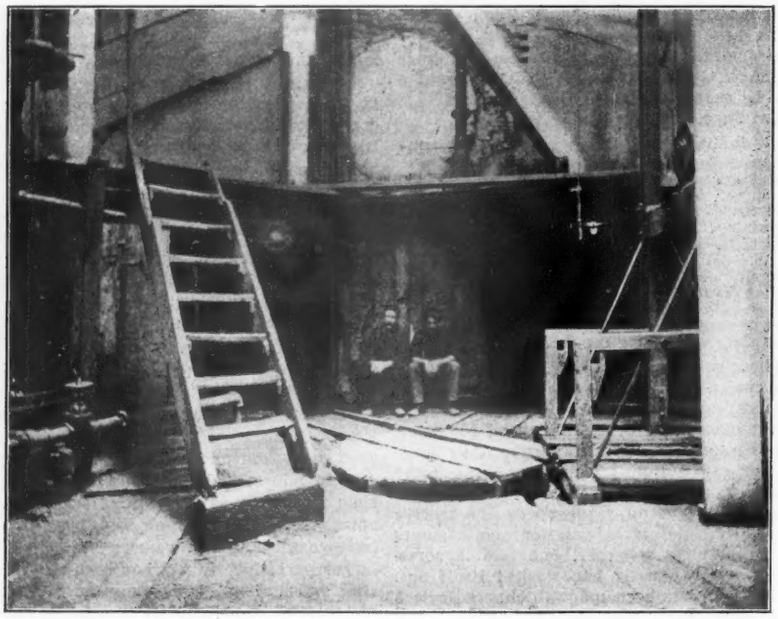


Fig. 3—View at Foot of Shaft Showing Entrances to the Two Tunnels.
(The circular opening above the men shows the location of the original air-lock.)

Mr. D. C. Haskin, the originator and projector of the work, was not an engineer, nor was he intimately acquainted with the methods of tunneling then in vogue. He had a vague and general idea of what had been done, but no knowledge of essential details. His only engineering experience was gained as a contractor on Western railroads. He was his own chief engineer, in fact if not in name. This may explain why he permitted the work which resulted in the fatal accident of 1880. The shield method of tunneling was then well known, as it had been thoroughly tested in England, and had been successfully employed in the Beach tunnel under Broadway at Warren street, New York. But Mr. Haskin was of the opinion that his own method of an unprotected heading possessed advantages in the lines of economy and rapidity. One point cannot be too strongly emphasized—no serious accident ever occurred in those headings, either in the one in silt at the New Jersey end or the one in sand at the New York end. While blowouts were more or less frequent, the time element was present in every case, so that the men always reached the locks before complete flooding took place. The fatal accident about to be described was due to causes widely different from those obtaining in the heading, and in no way affected the principle under which the work was carried forward.

The first work connected with the actual building of the tunnels was the sinking of a brick shaft on the western or Jersey shore of the river. This was circular in section, 30 ft. inside diameter, and the shoe was carried to a depth of 54 ft. below mean high water, or 60 ft. below the ground surface. It first passed through a loose filling of cinders 15 or 20 ft. thick and then entered silt. While the shaft was being lowered the water was kept out by two pumps.

The vibrations set up by the pumps and the friction of the side of the shaft disturbed the ground, especially on the side next to the river. This, working in connection with the water drawn under the shoe by the pumps, caused the ash filling to flow down the side to the pumps. It was therefore known that the material to be passed through was not in an undisturbed and compact condition; it was treacherous, and it afterwards proved its treachery.

Twenty-nine feet below the top of the shaft an opening was cut in the side next the river and an air-lock put in. This projected a few inches beyond the wall and was at a higher elevation than the crown of the tunnels. It was not the intention to start the tunnels at the shaft, but to begin them about 30 ft. from the shaft and afterwards connect them with the shaft. The connecting, or "temporary entrance," as it was called, was shaped like a funnel and was composed of rings 2 ft. wide and each 18 in. larger than the one just behind. The upper edge of the funnel was in a practically horizontal line. The outer ring was 20 ft. in diameter. After the completion of this chamber, excavation was begun at the outer ring, downward and sideways, to permit of the starting of the masonry of the two tunnels. This work was in silt which had not been disturbed, and was prosecuted in the same way as the heading described in our issue of June 3 last.

After the air-lock had been put in one of the first jobs was to provide sufficient protection for the inner door in case of a cave-in at this point. The projecting end of the lock was enclosed in a tube 6 ft. 4 in. in diameter, 8 ft. long, built of ½-in. plates well braced. So serious had become the trouble at this point that a large hole was dug immediately above it, the bottom covered with canvas and the earth replaced. The condition of things at this time is shown by the sectional elevation and plan, Figs. 1 and 2, which are modified somewhat from Burr's "Tunneling Under the Hudson."

It was now time to remove the temporary entrance and make a permanent connection between the shaft and tunnels—this was to be one large chamber embracing both tunnels. The four largest rings were widened and deepened and the masonry built. Of the remainder the upper third had been extended and the plate composing this carried down the shaft and fitted as closely as possible to it. While this work was going on the protecting tube over the end of the lock was removed.

During a change of shifts a blowout occurred at this spot, marked x in Fig. 1. Eight men had entered the lock and 20 were in the chamber. The falling débris blocked the lock door so that it could be neither opened nor shut. When it was found impossible to move the door the glass bull's-eye in the other end of the lock was smashed, and as soon as the air pressure had fallen the

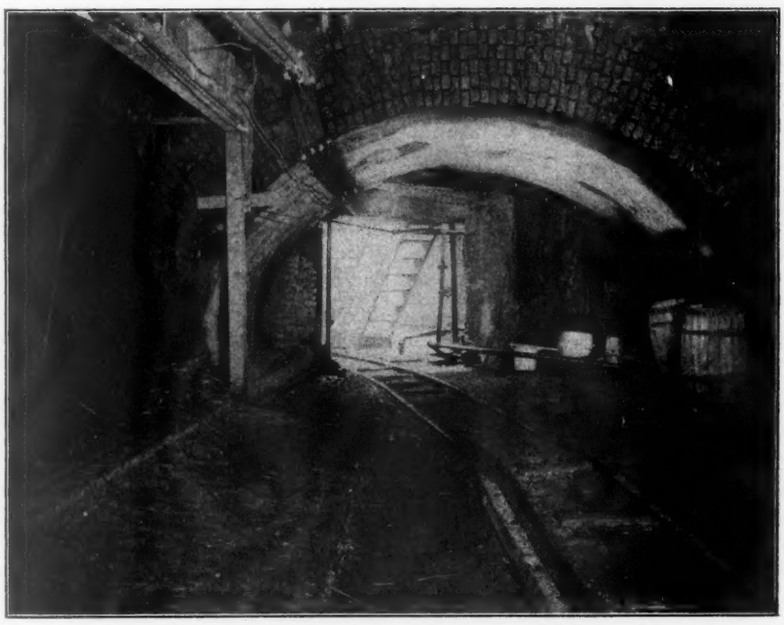
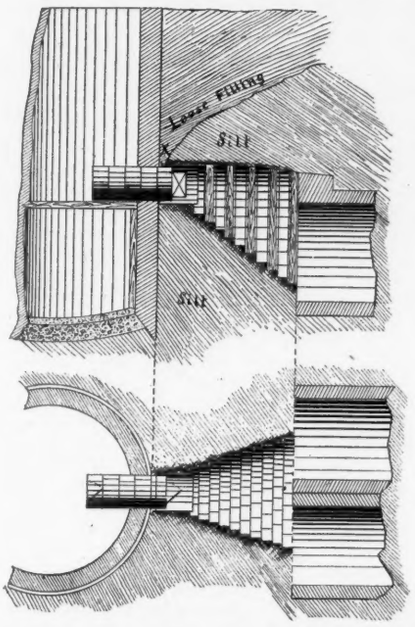


Fig. 4—End of North Tunnel Looking toward the Shaft.

*A previous article on the early history of the Hudson River tunnel by the same author was printed in the *Railroad Gazette*, June 3, 1904.

outer door was opened and the men in the lock escaped, all the others being drowned.

Concerning this work several facts stand out with great prominence. It had been found possible to build the tunnel by depending largely upon an equilibrium maintained between the air and water pressures. But that work had been done in silt, which had never been disturbed. In this case the material was known to be of such a loose character that it could not be relied upon to serve as a barrier between the water and air. The bottom of the tunnel was a slope on which, or in which, it was difficult to obtain a firm foundation upon which to rest the struts supporting the plates, so that an unusual reduction of air pressure would be almost sure to result in the giving way of the roof plates. The removing of the protecting tube was a piece of criminal carelessness. When needed most it was not on duty. It had been designed to guard against just such an accident as did happen, and it served no purpose whatever



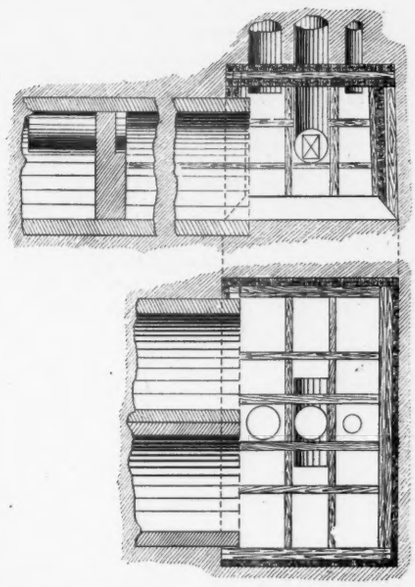
Figs. 1 and 2—Plan and Section of Shaft, Temporary Entrance and Completed Tunnels, New Jersey End.

except to protect the inner lock door, and yet for some reason, never satisfactorily explained, it was removed before the end of its usefulness. From this time forward engineers viewed the tunnel with suspicion.

To reopen the work a large caisson was sunk just over the temporary entrance. One working chamber covered both tunnels, and was joined to the shaft by two openings, as shown in Fig. 3, in which the circular opening directly above the men indicates the location of the original air-lock. The next engraving shows the working chamber after completion. Both pictures were taken by the writer in 1887, and are now used by permission of Harper & Bros.

In starting the north tunnel all the material had been removed before laying the masonry. A different method was tried with the south tunnel, and as it brought out the peculiar qualities of silt it may be well to describe it. An excavation about 3 ft. in height was begun at the crown and extended down each side and along the invert. In this way a ring was formed about 3 ft. wide, 5 ft. long and entirely surrounding a core of silt 15 ft. in diameter. This core was absolutely without support except at the two ends where it joined the parent mass. The superintendent was convinced that his bridge of silt had tenacity enough to hold its position until he could complete the circle of masonry. His experience in the heading had proved that silt, in its original state, settles very slowly, and it was this characteristic he took advantage of. The brickwork was started at the invert, the superintendent himself placing the first bricks in order to prove his confidence in the stability of the core. The masonry had been finished several days before the core had settled to the bottom.

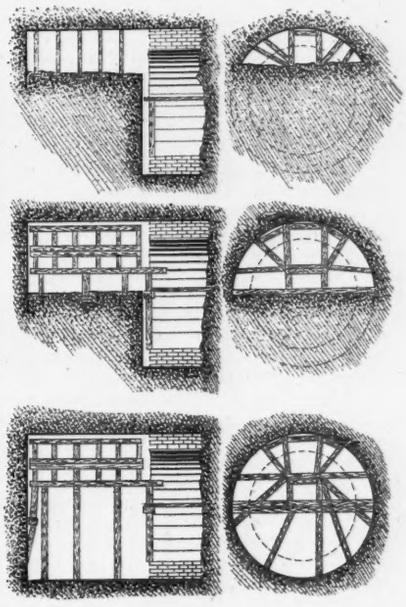
During the latter part of 1882, when the heading at the New York end was being successfully built through water-bearing sand, the writer said, in an article published in *Engineering News:* "The fact that the caisson was embedded in sand led to the belief among many engineers of high standing that an outlet could not be obtained and the tunnel started by the system of working by compressed air. Indeed, it has become unsafe to pronounce an unfavorable opinion in regard to any particular piece of work connected with the tunnel; in more than one instance obstacles which seemed to present an insurmountable barrier to all future progress have been met, conquered, and the work has gone forward. New devices and plans have kept pace with new difficulties. At first glance the sand above mentioned seemed to contain all the characteristics requisite for a first-class insurmountable obstacle. Upon the least reduction of the air pressure this material would follow the water into the caisson; the smallest opening afforded a ready passage. The water and sand could be kept quiet as far down as the air pressure was carried, and no further; and if a trench were dug, or undertaken, the upward pressure, due to the difference between the air pressure and head of water, or depth of excavation, would fill the trench with sand and water about as fast as it could be taken out, and the adjacent material would then be in no better condition than at first."



Figs. 5 and 6—Plan and Section of New York Caisson, Tunnels, Bulkhead and Air-Lock.

It was decided to reach grade and begin the permanent work upon the two tunnels by means of a caisson. This was designed by S. H. Finch, then chief engineer of the work, and under his direction it was sunk and the heading extended through sand and through the dock piles, many of which entered more than half way through the tunnel. The caisson was of wood, of the usual rectangular form, and furnished with three independent air-locks, one for men, one for material and one for long timbers. It was large enough to span both tunnels and was sunk to the invert. The caissons, tunnels and first bulkhead, with its air-lock, are shown in Figs. 5 and 6.

To begin work, an opening conforming with the exterior of the north tunnel was cut through the side of the caisson. Beginning at the top, flanged iron plates were inserted and made fast to the caisson. This work was pushed forward and down each side, and resembled the method pursued at the Jersey end, but was much more difficult because of the nature of the material. The plates were braced as securely as possible as soon as they were inserted, but settling could not be prevented, as there was no adequate foundation upon which to place braces. In addition, this unequal settling threw the plates out of line and opened the joints, so that the packing of silt, brought for this purpose from the other side, blew out. As the chamber was enlarged this trouble increased, and it finally became imperative to provide some means for holding the plates in position. A 12-in. timber was placed with one end resting against the side of the caisson and the other extending to the heading. Two tie-rods having turnbuckles reached from the outer end of this boom to the top of the caisson. In this way a firm support was obtained for the braces. After the lining of plates had been finished the section was cleaned out and the masonry laid.



Figs. 7, 8 and 9—Methods of Advancing New York Heading Through Sand.

The sketches, Figs. 7 to 9, show the method of building a section, which was about 10 ft. in length. The plates composing the forward end of the section, or in other words, the new heading, were always kept in advance of the heading, which had already served its purpose in the section just finished. In other words, the lower edge of the forward heading was always kept at a lower level than the upper edge of the heading being taken down, as is indicated very clearly in Figs. 7 and 8. This construction provided a seal against the entrance of water as long as the air pressure was maintained, and resembled in principle the compartments of the ordinary shield.

The hard work necessary in putting in the

roof plates can be imagined. It was impossible to leave the sand exposed even for the short length of time required for inserting a plate. In cases of this kind neither silt nor sand would prevent the rapid escape of air and the falling down of the uncovered surface. So a simple and effective expedient was adopted which provided such protection that the sand was never exposed at all. Light wooden poling strips ½ in. thick, 2 in. wide and about 3 ft. long were driven into the sand parallel with and ahead of the plates already in place. The rear ends of these strips were then pushed up and pulled back until they rested upon the finished ring. In this way a false lining was prepared which, with the assistance of the air pressure, held the sand long enough for the insertion of the plates.

A short distance from the shaft a masonry bulkhead was built in the north tunnel and an air-lock put in, as shown in Fig. 5.

More than once the work was flooded by the air escaping; but, as stated above, no one was ever injured by a blowout. While working upon the fifth section from the shaft a blowout occurred in the fifth row of plates composing the bulkhead. The men all got out and the work was flooded. A diver was sent in to examine the condition of things. The simple fact of sending in a diver to ascertain the extent and location of the damage yielded results that were of the greatest importance afterwards. The air from his helmet collected at the crown of the tunnel, and this suggested the starting of the compressors. In a short time the air filled the top of the tunnel down to the upper edge of the air-lock doors. This provided a headroom of air when the men were in an upright position, the water then being about breast high. Men entering the tunnel would wade down to the first lock door, dive through it, pass through the lock and dive through the inner door into the heading.

The tunnel was filled with air to the upper edge of the blowout. This provided a breathing space for the men, but compelled them to perform all the work of repairing under water. Their troubles can better be imagined than described. In addition the job was a slow one, as the water could only be lowered as the repairs progressed and the bulkhead was carried down.

Afterwards, other blowouts took place, but beyond flooding the work they were not of a serious nature. In these instances it was always easy to free the heading of water because the trick had been learned. The attempt was never made to pump the water out of the tunnel. The sand was perfectly porous and water found a ready passage through it. If this had been tried the water would have flowed in through the largest opening—naturally the blowout—and the extent of the damage would only have been increased. Again the pumping capacity at the command of the engineers was not sufficient for handling the Hudson River and its tributary, the Atlantic ocean even if a spillway had been convenient.

But by forcing air into the heading the displacement of water began at the point of least resistance, was in a direction most favorable for preventing any further entrance of sand, and the escaping air worked on the intermittent flow, which is present during every blowout. If these simple facts had been known and appreciated by engineers subsequently in charge of the work, thousands of dollars and months of time would not have been expended in vain attempts to reopen the New York end of the tunnel.

The Simplon Tunnel about the middle of September encountered a hot spring at the south end (where alone work is prosecuted). The hot springs heretofore have been in the other end of the tunnel. The south end, however, was long ago provided with a capacious drainage channel on account of a veritable river of cold water which delayed the work there some weeks, and the new hot spring was expected to cause little delay, so that a passage through was still expected about the middle of October.

American Locomotives.*

Since 1893 the types of passenger locomotives, as distinguished by their wheel arrangement, have completely changed, and the eight-wheel American type, 4-4-0, is no longer built for fast express service. In passenger service, the competition of the different roads advertised itself by offering greater luxury and magnificence in sleeping cars, parlor, buffet and dining cars, of elaborate finish, greater length and greater weight. The length of these cars of modern construction is 70 ft., and their weight 120,000 lbs. The number of passengers hauled in a solid vestibuled train made up of such cars is comparatively small, and the weight of train per passenger very great. Such service is necessarily expensive. It is not profitable, and it is probably the most luxurious and most inefficient of any passenger service in the world. Trains of eight to ten of such cars weigh from 400 to 500 tons, and to haul them at average speeds approaching 50 miles per hour required a large increase in the weight and power of the locomotives. It was not possible to arrange a boiler of sufficient capacity on the 4-4-0 American eight-wheel type, and the Columbia, or 2-4-2, was first substituted, as any arrangement with trailing wheels allows a wider fire-box to be carried entirely behind the drivers, and also admits of a longer boiler barrel. For high speeds it was considered safer to use a four-wheel leading truck, and the best experts on track are of the opinion that the four-wheel truck causes less irregular deflection in the track and roadbed in advance of the drivers than a two-wheel truck, and therefore results in smoother riding and less injury to track. The Atlantic type, 4-4-2, therefore, has become a favorite type of passenger locomotive for express service. It has been built in large numbers in the United States, and is being introduced gradually in England, France and Germany. When still greater power is demanded for passenger service, and a larger boiler is necessary, the Pacific type, 4-6-2, is used, this having six drivers, with the same arrangement of leading and trailing wheels. Locomotives for burning anthracite coal have quite a different appearance from those for bituminous coal, as the wide fire-box in the former requires the cab to be placed well forward about the middle of the boiler, and the arrangement of the cab fixtures, the dome and the bell, are not such as to result in a handsome machine.

FOUR-CYLINDER BALANCED COMPOUNDS.

For medium-weight trains and high speeds, it was desirable to retain the Atlantic type, with only four drivers, but when this type was developed to an extreme size the total weight on the drivers was as great as 100,000 lbs., and the weights of the reciprocating parts with simple cylinders were so great that the centrifugal force of the extra weight in the counterbalance increased the pressure on the rail at high speeds to 20 or 30 per cent. in excess of the static load. In order to overcome these difficulties, the four-cylinder balanced compound was introduced by the Baldwin Locomotive Works, and first used in regular passenger service by the Santa Fe in 1903. Four engines of this kind were used on the Santa Fe in 1903, and, during 1904, forty additional engines were ordered. In this engine, the four cylinders are placed in line laterally, and they are all connected to the front axle, which is cranked. The arrangements of the cranks are such that the reciprocating parts balance each other, and the pressure on the rails is increased very slightly at high speeds. The engines ride very smoothly, and their success is indicated by the large additional order which has been given. In this type, as the force of all four cylinders is transmitted through the crank axle, the stress in that axle must be great, and two of them have cracked in the main rod bearings. In repairing these axles, a 4-in. hole has been bored through the crank portion at the bearing, and a steel pin driven through and riveted. In future work, the cranks will be constructed in this way. A modification of this type, in which the outside cylinders are connected to the rear drivers, has been built by the Baldwin Locomotive Works for the Burlington. In this way the stresses from the cylinders are divided between the two axles. The cylinders are all placed in line laterally, but the piston rod and main rod of the outside cylinder are longer, so as to reach the rear driver.

Another four-cylinder balanced compound passenger engine of the Atlantic type has been designed by Mr. Francis Cole at the Schenectady Works of the American Locomotive Company for the New York Central. In this engine, the high and low-pressure cylinders are connected to different drivers. The high-pressure cylinders on the inside are placed in advance of the low-pressure cylinders, and they are connected to the front axle, which is cranked. The low-pressure cylinders on the outside are connected to the rear drivers. The four-cylinder engines, by both the Baldwin and the American locomotive companies, are operated by the Stephenson link motion, with one link for each pair of cylinders. In the Baldwin (Vauclain) engine, a single valve controls the steam for the high and low-pressure cylinders. In the American Locomotive Company (Cole) four-cylinder engine, there is a piston valve for each cylinder, but the valves for the high and low-pressure cylinder on one side are operated from one valve stem. It may be interesting to compare these arrangements of cylinders, valves, rods and links, with the Von Borries and de Glehn four-cylinder compounds.

Cole.—High-pressure cylinders inside, but in advance of the smoke-box, driving front driving axle. Low-pressure outside, in line with the smoke-box, driving rear driving axle. Two piston valves on a single stem serve for each pair of cylinders, and each valve stem is worked from an ordinary link motion.

Vauclain.—High-pressure cylinders inside and low-pressure outside, all in the same horizontal plane, in line with the smoke-box, and all driving the front driving axle. This is as in the Von Borries, but a single piston valve worked from a single link motion effects the steam distribution for the pair of cylinders on each side.

De Glehn.—High-pressure cylinders outside and behind smoke-box, driving the rear drivers. Low-pressure cylinders inside, under smoke-box, driving crank axle of front drivers. Four separate slide valves and four Walschaert valve gears, allowing independent regulation of the high and low-pressure valves.

Von Borries.—High-pressure cylinders inside and low-pressure outside, all in the same horizontal plane, in line with the smoke-box, and all driving the front driving axle. Each cylinder has its own valve, but the

*Abstract of a paper by Wm. Forsyth presented before the International Engineering Congress, St. Louis, October, 1904.

two valves of each pair of cylinders are worked from a single valve motion of a modified Walschaert type. This arrangement allows of varying the cut-off of the two cylinders, giving different ratios of expansion, which, however, cannot be varied by the engineman.

FREIGHT LOCOMOTIVES.

The demand for greater power in freight engines was the result of the introduction of the steel car, which increased the lading of freight cars from the ordinary capacity of 25 and 30 tons to 40 and 50 tons. The draft gear of these cars being entirely of steel and the automatic couplers of cast steel, made it possible to haul large trains without danger of breaking in two. The rating of locomotive capacity by the ton tended constantly to increase the trainload to the maximum, and the economy of this method of transportation, as compared with the old method, which gaged the train simply by a given number of cars, resulted in a demand for larger engines and greater tractive power. The consolidation type of freight engine, 2-8-0, which was first used in the United States in 1866, is still the prevailing type, as it can be built with a boiler large enough for the heaviest through freight service. For mountain grades, when pushing engines are required, the Decapod and Mastodon types are often used, and a 12-wheel Mallet articulated compound engine has been built during 1904 at the Schenectady Works for pushing on heavy grades.

BOILERS.

The changes in locomotive design, in order to obtain greater power, it will be observed, have been largely due to the use of a larger boiler. The barrel was not only greatly increased in diameter to accommodate a larger number of tubes, but its length was made greater, so that tubes 20 ft. long are frequently used. In 1893 the outside sheet of the fire-box in most locomotives was flush with the frame, and the width inside was 42 in. The larger express engines on fast schedules burned such a large quantity of coal per hour that the rate of combustion was often forced to 150 and 200 lbs. of coal per sq. ft. of grate per hour. The same was true of freight engines when hauling maximum trains, even at comparatively slow speeds. The strong blast required for such high rates of combustion was sufficient to pull unconsumed fuel through the tubes to the extent of 10 or 15 per cent. of the total coal fired, and throw it out of the stack, and the rate of evaporation was thus reduced. Even with such high rates of combustion, it was not possible to burn sufficient coal on a grate 42 in. wide to supply large engines with steam. A fast passenger engine, with cylinders 19 in. x 24 in., burned three tons of coal per hour, and since that time passenger engines with 45 per cent. greater cylinder volume have been built. It was found necessary to increase the width of the fire-box to 5, 6 and 7 ft., and such boxes are known as "medium-wide" fire-boxes, to distinguish them from those 8 ft. wide, used on anthracite boilers. The wide fire-box was easily applied to types of passenger engines having trailing wheels, such as the Columbia, Atlantic and Pacific, and in the consolidation type the diameter of drivers is so small that the wide box could be easily extended over the rear pair of that type. In placing the fire-box entirely back of the drivers on passenger engines, the throat sheet has been inclined forward, so that the front water leg conforms somewhat to a line parallel with the circumference of the rear driver, and the tube sheet is thus somewhat ahead of the water leg in that region. This is done for the purpose of retaining a proper proportion of weight on the drivers, to avoid tubes of too great length, and to improve the circulation of water along the lower side sheets. The front tube sheet is often placed some distance back of the cylinder saddle for the purpose of avoiding excessive tube length.

The Spacing of Tubes.—The development of the locomotive in America has been based upon a desire for increased tractive power, this power being the maximum to be obtained when using steam at nearly full stroke, and a mean pressure equal to 85 per cent. of the boiler pressure. With an average coefficient of adhesion of 25 per cent., the weight on the drivers is determined, and, in order to obtain it, a large boiler diameter was found necessary. Having a large shell, it was thought desirable to fill it as full of tubes as possible, with bridges of only 5/8 in. between the tubes, and when the tubes are coated with scale the space is reduced to 3/8 in. at least. At the same time, the height of the evaporating surface above the lower tubes was greatly increased, and, with it, the length of travel of steam bubbles. Under such conditions, the tubes are not constantly covered with water, and they become overheated, resulting in leaks at the tube sheets. This has been one of the most serious troubles in the operation of large locomotives, and in locomotives built in 1904 there is a marked tendency to use a less number of tubes in a shell of the same size, and to increase the space between tubes from 5/8 to 3/4 or 7/8 in.

It was found that the maximum efficiency of the tube-heating surface could not be obtained by such close spacing, and it is believed that a higher rate of evaporation per square foot of heating surface will be obtained when the tubes are spaced further apart, and that, therefore, an equivalent or larger boiler capacity will be obtained with a less number of tubes with the wider spacing. An illustration of this is found in two lots of Pacific type passenger engines, built by the same works for the same road, those in 1903 having the close tube spaces and those in 1904 the wider spaces. The diameter of the boiler is the same, and the tubes are 20 ft. long in each case. Those built in 1903 had 328 tubes and those in 1904 245 tubes, a difference of 83. The total heating surface is reduced from 4,078 to 3,053 sq. ft., a difference of 1,025 sq. ft., or 25 per cent. The width of the mud ring and water space at the bottom is increased to 5 in. With such proportions for the water space between the tubes and in the water leg, the circulation of the water is greatly improved and the efficiency of the heating surface is increased.

LOCOMOTIVE OPERATION, AS AFFECTED BY THE FIREMAN.

In the operation of large locomotives with wide fire-boxes it is found that the fuel economy, the hauling capacity and the boiler repairs (especially fire-box sheets and tubes) are all materially affected by the limitations of the strength of the fireman, and by his lack of skill in keeping the grate covered uniformly with coal. From the facts contained in recent reports to the Master Mechanics' Association, the following conclusions may be drawn:

First, that in recent years poor material has often been employed for firemen. Second, that poor firemen are most extravagant in coal consumption when working wide fire-boxes. Third, that the irregular firing of wide fire-boxes has resulted in leaky tubes and cracked sheets. Fourth, that the capacity of a large locomotive is easily limited by the endurance of the fireman, whether good or bad. Fifth, that the economic size of locomotives may in some instances have been exceeded on account of the limitations of the fireman's strength.

The care with which wide fire-boxes should be fired is not generally appreciated by the men, and is largely the cause of the numerous troubles due to leaking, which are experienced with this type of boiler. It is more difficult to maintain an even fire on a large grate than on a small one, and as there is a greater tendency to irregular temperature in the former, it is the direct cause of leakage. The admission of larger amounts of cold air to the furnace than is necessary for combustion has a tendency to lower the average temperature of the fire-box gases, and thus to reduce the rate of evaporation.

It is, for this reason, easily possible for the fireman to effect unfavorably the coal performance with wide fire-boxes, even when he is endeavoring to do his best work. The rules relating to the privileges due to priority of service of firemen have had a tendency to place the youngest and most unskilled men on the large engines with wide fire-boxes, because the older men prefer the lighter work on the smaller locomotives. Although the rate of wages paid firemen is higher than that received by skilled mechanics, who have spent several years in learning a trade, or of clerks who are perhaps better educated, yet the fireman's service is no longer attractive to a good grade of men, on account of the laborious work required in handling the large amount of coal consumed per trip by large locomotives.

It has been shown in the reports referred to, that, as now operated, the wide fire-box is not superior to the narrow one in economy of fuel, and coal consumption must be nearly proportional to the horse-power developed with either type of boiler. As the large locomotives have a horse-power capacity nearly double that of the medium-sized engines used a few years ago, the amount of coal to be handled per hour when these engines are working at normal capacity must be twice as great. While the fireman may be able to handle this amount of coal for the first few hours, he cannot keep up the work uniformly for the whole trip. The Master Mechanics' report on automatic stokers emphasized this fact in explaining the conditions under which the machine stoker will prove most valuable:

"When the engine is loaded to maximum capacity the automatic stoker will not tire, and consequently it will enable the engine to carry maximum pressure all of the time and get the full benefit of the tractive power of the engine over a long, continuous trip; this cannot be done by hand-firing."

The power of the large locomotive is thus limited by the fireman in his failure to maintain uniformly full boiler pressure, due to the limitations of his physical endurance. So far as irregular firing results in failures of the boiler and fire-box, to that extent does the fireman determine the mileage service of the engine, for such failures require it to be laid up in the roundhouse or shop, and there is a loss, due not only to cost of repairs, but to the limited service obtained on the road.

If the above statements be considered with relation to the size of locomotives as measured by their coal consumption per hour, it would appear quite possible that a given tonnage could be handled by a locomotive of medium size, which would burn economically the same amount of coal used by a large locomotive on the same trip. Having reached the limit of the capacity of the fireman to shovel coal enough to maintain uniform boiler pressure, is it a profitable move to build locomotives still larger, and in some instances has not the economical size of hand-fired locomotives been more than reached? With oil fuel or with a machine stoker it is possible to force steam production and maintain uniform pressure beyond the maximum of present consumption, and it is only by the use of such measures that the

continued growth of the locomotive in America may be justified.

AUTOMATIC STOKERS FOR LOCOMOTIVES.

The necessity for an automatic stoker for the large locomotive, either passenger or freight, is quite generally recognized, and the requirements have been met in a very satisfactory manner by at least one form of stoker. It is strange, therefore, that a stoker which has been upon the market for several years, and which works so successfully, does not become regularly adopted by the railroads, which seem to need some such appliance to assist the fireman in his arduous work. The testimony as to the success of this device is the most convincing of any relating to locomotive improvements (containing such radical changes in methods of operation) which have been introduced in many years. The reports of the laboratory tests at Purdue show it to have given a very satisfactory performance. The testimony of motive power men who have had quite a number of stokers in use is entirely favorable to the device, and the opinion of the superintendent of our largest locomotive works is that the stoker is the coming device.

PISTON VALVES.

The flat slide valve is almost always provided with balancing strips, but, on account of imperfect lubrication, its excessive friction makes it difficult for the engine driver to change the cut-off, and the want of sufficient rigidity in the ordinary design has led to the use of a very heavy valve gear on modern locomotives. The piston valve was introduced for the purpose of securing a balanced valve, thus reducing valve friction. It has been designed in various forms, and much experimental work has been done with packing rings of different shapes. Although many objections have been made to the piston valve on account of broken packing rings and leakage, yet it has been gradually developed and successfully applied, so that it may be regarded as well established practice in America.

The use of the piston valve has modified materially the design of the cylinder and saddle, as well as the front frames, and in such designs there is opportunity to make a stronger construction of both cylinder and frame than with the flat valve. The packing rings used by the Baldwin Locomotive Works are rectangular and nearly square. The construction used by the American Locomotive Company for packing rings includes a bushing, with L-shaped rings on each side of it, and a large number of locomotives are now running with this form of packing ring.

The principal objection which has been urged against the piston valve is the loss due to leakage, and it was supposed that this was much greater than with flat valves. The subject was carefully investigated by a committee of the Master Mechanics' Association, and the following figures are taken from a report presented at the convention of that association in June, 1904. The amount of leakage per hour was measured with each type of valve, one series with valves at rest and another with valves in motion. The best results obtained from piston valves show a leakage of 268 lbs. per hour, and from flat valves, 348 lbs. The worst cases of leakage were 2,880 lbs. with piston valves and 2,610 lbs. with flat valves.

Incidentally, it was found that the principal cause of leakage was poor fitting of the rings, and the conclusion was reached that if equal attention is given to each kind of valve, the piston valve would show less leakage. Flat valves are free to lift from the seat, and thus relieve the cylinders from water and undue compression, but piston valves cannot lift, and provision must be made for the rapid removal of water from the cylinder; therefore it is essential that relief valves and well-designed by-pass valves be used in connection with piston valves.

The question of the lubrication of piston valves while drifting is one which is still in the experimental stage, but it is also one to which proper attention must be given, in order to make the use of such valves entirely satisfactory.

VALVE GEAR.

The use of the Walschaert valve motion on the Baltimore & Ohio, Mallet articulated locomotive, and on the Pennsylvania de Glehn four-cylinder compound, which are now on exhibition at St. Louis, has again brought the merits of this gear to the attention of American designers. These two locomotives represent extreme conditions as to the speeds for which they are intended. The one is for slow speed on heavy grades, the other for high-speed passenger work. This would indicate that the Walschaert gear is well adapted to any kind of service—freight or passenger. It is fortunate that a well-designed gear of this type will soon be seen in operation in the United States, and its performance on these locomotives will be watched with interest.

This gear has been used for many years on the State Railways of Belgium, and it is also used extensively in Germany and France. In the latter country it has been given preference over all others for the high-speed balanced compounds, which have made such remarkable records, and, on this account, it is found on the French locomotive which was built for the Pennsylvania.

The chief difference between the Walschaert and the Stephenson motions is the constant lead with the former when the valve travel is changed. This is due to the fact that at the end of the stroke the cross-head alone determines the position of the valve, and as the cross-head always has the same position at the end of the stroke the valve will also have a definite location, and the travel may be decreased but the lead remains constant. For high-speed locomotives, of the ordinary simple two-cylinder type, the constant lead may not be regarded as desirable, as early cut-offs are then used, and it is necessary to have greater pre-admission, when the cut-off is so short, in order to permit the steam to enter the cylinder without excessive wire-drawing. With the four-cylinder balanced compound, which is the most promising type for high-speed work, the cut-off need not be short. The record of the indicator cards taken from a locomotive of this kind on the Northern of France, as given in Mr. Sauvage's paper, shows that at 77 miles per hour the cut-off was 45 per cent. in the high-pressure cylinder and 67 per cent. in the low-pressure cylinder. The Joy valve gear has a constant lead, and it is used quite generally in England in connection with inside cylinders, and it has not been found objectionable on account of this peculiarity. As far as the distribution of steam is concerned, the Walschaert valve motion will produce results as good as, if not better than, the Stephenson shifting link, and it has some mechanical advantages which should recommend it as well adapted to modern locomotive practice in the United States.

A valve gear outside of the frames is conveniently inspected and repaired, while one inside of the frames is certainly in an awkward position for either operation. With inside cylinders and crank axles there is little room for eccentrics and links, and if all this be removed it allows ample length for main pin bearings, and it is then possible to have an inside bearing for the crank axle. The Walschaert gear, as ordinarily designed, is not symmetrical in a vertical plane, and there is a tendency to lateral bending and unequal wear when so constructed. In the engine referred to, Mr. de Glehn has taken special care to avoid these objections, and his design shows well-balanced wearing surfaces of ample proportions, which should be quite durable.

The point to which the writer wishes to call particular attention is the great contrast in the weight of the moving parts and the size of the bearings when this Walschaert outside gear is compared with similar parts of a Stephenson link motion driven by eccentrics. A prominent superintendent of motive power, who has made a special study of indicator cards, and who has given much attention to valve gears, in a recent discussion on "Modern Tendencies in Locomotive Design in America," made this statement:

"I consider that the increased complication and weight of the valve motion is an exceedingly serious matter in giving distorted steam distribution, due to the destructive effect of the valve motion in causing wear and tear."

The reports on "Weights of Detail Parts of Locomotives"* give the weights of parts of the Stephenson valve gear for large locomotives, as follows, in pounds: Eccentric 212, eccentric strap 225, eccentric rod 125, link 148, rocker arm 248, transmission bar 128, valve rod 66, valve yoke 90, valve 211. These figures indicate that the Stephenson valve gear, including the eccentrics and straps, as found on modern locomotives, has become a very ponderous affair. Some attention has been given to the valve pattern, in the effort to make it as light as possible, but the same care has not been taken with the moving details connected with it, and which easily become a disturbing factor at high speeds if made too heavy.

The principal load which comes on the eccentrics and straps, causing them to heat, is not the friction of the valve, but it is that due to the inertia of the reciprocating parts of the valve gear, the motion of which is reversed twice for every revolution. If the rocker arm is included, the weight, as found above, of the moving parts from valve to eccentric strap for one cylinder is 1,052 lbs., and at high speeds the energy of this moving mass must impose a heavy load on the eccentrics.

The eccentrics and straps are the most difficult details in the locomotive machinery to keep lubricated properly, and it requires constant vigilance to prevent them from heating. When they do heat and cut, and the straps are taken down, their location inside the frames is the most inconvenient possible, and with the increasing weight of the machinery this part of the locomotive repairs has become very laborious and expensive. More attention should be given to the reduction of the weight of the moving parts of the Stephenson valve gear, or some other type should be used. The Walschaert gear, located outsided the frames, is easily accessible, and very convenient for inspection, lubrication and repairs. The main driving bearings are two small pins with bushed bearings, and the contrast with the heavy and cumbersome eccentrics and straps, which are their equivalent in a valve gear system, is very striking. This gear is simple and light throughout, and it has much in it to be recommended for overcoming the objectionable features of the shifting link motion driven by eccentrics.

LOCOMOTIVE FRAMES.

In the design of locomotive frames the bar frame is still the general practice, and, for the pedestal portion, it does not seem feasible to adapt any other form to the gen-

*Proceedings Master Mechanics' Association, 1903, p. 187.

eral design of American locomotives. With trailing wheels, double-plate frames are frequently used, the plates being 13 in. deep, the inner one 1¾ in. thick and the outside one 1¼ in. In one design, a deep plate, 2 by 32 in., is used between the cylinder and the saddle, but this portion is either forged or cast with the usual bar extending to the pedestals. In a double-bar front frame, the top bar extends back over the front pedestal. A great deal of study has been given to frame design, but broken frames are as frequent as ever, and their repairs, due to such fractures, are expensive. No satisfactory explanation or remedy for broken frames has been found, but the following have been suggested: First, poor design; second, imperfect welds or faulty material; third, the inertia of the boiler with reference to frames when the bumpers strike an obstruction or when brakes are applied suddenly, where high cylinder saddles are used; fourth, the presence of water in the cylinders, with piston valves and inefficient relief valves. While any one of these may not cause broken frames, yet they are contributory, and when several are acting at once they produce stresses greater than the resistance of the material. The cracks in frames are not confined to any definite locality, but appear at all pedestals, and as many back of the leading axle as in front of it. The fractures are also found as frequently in the full section as at bolt holes.

More locomotive frames are now made of cast steel than of forged iron, and steel is regarded as the better material for this purpose. The tensile strength is 75,000 lbs. per sq. in., as compared with 50,000 lbs. per sq. in. for hammered iron. The cast-steel frame contains no welds, and is uniform in quality throughout its length. The projections required for driver-brake details, bearings, etc., for the valve motion are conveniently cast in steel, but they complicate the forging when made of iron.

While steel is 50 per cent. stronger than iron, yet almost as many cast-steel as wrought-iron frames have broken, where similar conditions, as to design and service, have prevailed. The reason of this is probably due to a lack of annealing, or improper annealing, or overheating of the casting. It is evident that the proper heat treatment of cast-steel frames is not well understood, or it is not usually applied. The quality of steel which should be used for locomotive frames is indicated by the following specification: Tensile strength, from 65,000 to 75,000 lbs. per sq. in.; elongation in 2 in., not less than 15 per cent.; to be annealed thoroughly. Chemical composition desired:

	Acid.	Basic.
Carbon	0.28	0.35
Phosphorus	0.05	0.06
Sulphur	0.05	0.06
Manganese	0.60	0.70

One advantage of cast-steel frames is the rapidity with which they can be manufactured; and they are also convenient for railroads which do not possess heavy hammers suitable for forgings of this size. Cast-steel frames require some work in straightening in the smith shop before they are ready for the planer. The cost of machining is also high, on account of the rough and hard surface, but the total cost finished is not more than two-thirds that of forged-iron frames. The foregoing information on frames is obtained partly from a report of a committee of the American Railway Master Mechanics' Association, June, 1904. This committee recommended as remedies for broken frames the following: 1.—Rational design; 2.—Cast steel to proper specification and good annealing; 3.—Provide such bracing as will prevent "weaving" (that is, movement of one side independently of the other); the bracing should be designed so that the bending will be synchronous; 4.—The clip pedestal binder is preferable to thimble and bolt; 5.—Cylinders should be drained properly.

LOCOMOTIVE PERFORMANCE.

Few reliable tests of modern locomotives have been made, and it is difficult to get accurate data as to their performance. The tests which are now being conducted by the Pennsylvania Railroad Company, in their plant in the Transportation Building, St. Louis, are the most comprehensive ever attempted, and they promise to show the most valuable results ever obtained by such methods. They are the only laboratory tests which have been made with the large locomotives representing present practice, and, as the reports are not now available, they are here recommended for future reference to those interested in the most refined measurements of locomotive performance.

An indication of the capacity of large passenger locomotives may be had from the performance of those handling the Alton trains between Chicago and St. Louis, where the engines of the Atlantic type haul nine cars, weighing 500 tons, at an average speed of 46 miles per hour. These engines weigh 183,800 lbs., and the weight on the four drivers is 103,700 lbs. The engines of the Pacific type, on the same road, haul 12 cars, weighing, with passengers and baggage, 675 tons, on the same schedule of 46 miles per hour. These engines have a total weight of 219,000 lbs., with 141,700 lbs. on six drivers.

Comparative Cost of Wood and Steel Frame Factory Buildings.

BY H. G. TYRRELL.*

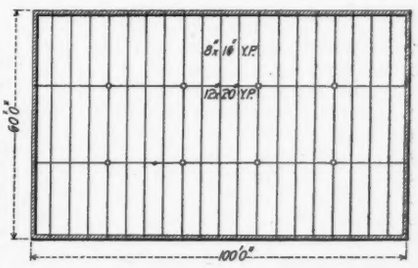
The following estimates give the comparative costs of a factory building, framed in slow burning wood construction, and steel fireproof construction. The building is 60 ft. x 100 ft., and six stories high, containing six floors and roof. The floors are designed to carry an imposed load of 100 lbs. per sq. ft. The building has windows in all four sides and the walls in both cases carry the ends of the floor-beams. The thickness of walls in the basement is 24 in., while in the first four stories it is 17 in. In the remaining two stories the wall is 13 in. thick. The estimates are for the structural part of the building only, including walls, columns, floors, roof, excavation, doors and windows, foundations, but do not include any partitions, stairs, elevator, plumbing, heating, lighting or wiring.

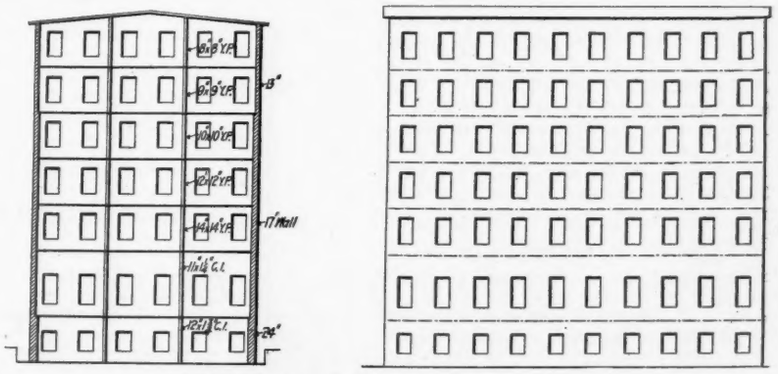
The framing for the slow burning design is as follows. Eight tiers of columns, spaced 20 ft. apart in both directions which carry the floors and roof. From the roof down through four stories, the columns are yellow pine. In the lowest of these stories the size of column used is 14 in. x 14 in. Below this where a greater size would be required than can be secured economically, round cast-iron columns have been used, 11 in. x 1¼ in. in the first story, and 12 in. x 1½ in. in the basement. All the columns have cast-iron bases, 3 ft. square and 16 in. high. Lengthwise through the building in the floors, run two lines of 12 in. x 20 in. yellow pine, which rest on the brackets of cast-iron column caps. The cross floor-beams are 8 in. x 16 in. yellow pine spaced 5 ft. apart. At the columns they rest on column caps, and at intermediate points they hang from the 12 in. x 20 in. header beams by means of wrought iron stirrups. In the walls the cross floor-beams rest on cast-iron wall plates, 9 in. x 20 in. x ¾ in. The floor is made of ⅞-in. matched maple, laid on 1¾ in. yellow pine. The roof is similar in construction and has a tar and gravel covering.

The quantities of material in the building as outlined above are as follows:

Excavation	1,800 cu. yds.
Cellar cement floor	6,000 sq. ft.
Foundation concrete	150 cu. yds.
Brick	39,000 cu. ft.
238 windows	4 x 7 ft.
Roofing	6,000 sq. ft.
Yellow pine timber	116,000 ft. B.M.
Yellow pine flooring	73,000 ft. B.M.
⅞-in. matched flooring	46,000 ft. B.M.
Iron work	46 tons.

The estimated cost of this design is $35,000, which is equivalent to 6.1 cents per cubic foot of the building, or 83 cents per square foot of the entire area of all the floors. The interior framing of floors and columns, including wall plates, columns, caps and bases and stirrup irons, is 27 cents per square foot of floor area.





Slow-Burning Factory Building.

In the fireproof design the arrangement of beams and columns is similar to that for the slow burning design. Riveted steel columns are used from cellar to roof, and the floors are framed with steel beams. The flooring between the beams is reinforced concrete. In this case the quantities are as follows:

Excavation	1,800 cu. yds.
Cellar floor	6,000 sq. ft.
Foundation concrete	150 cu. yds.
Brick	39,000 cu. ft.
238 windows	4 x 7 ft.
Roofing	6,000 sq. ft.
Steel columns	105 tons.
Steel beams and wall plates	252 tons.
Concrete floor and roof	42,000 sq. ft.

The cost of the building in this case is

*Chief Engineer, The Brackett Bridge Co., Cincinnati, Ohio.

$57,000, which corresponds to 10.2 cents per cubic foot of building, or $1.36 per sq. ft. of the total floor area. Floors and columns cost 75 cents per sq. ft. of floor area.

Hence the comparative estimates are as follows:

	Construction, Slow-burning.	Fireproof steel.
Cost per cu. ft. of building....	6.2 cts.	10.2 cts.
Cost per sq. ft. floor area.....	83 cts.	136 cts.
Cost of floors and cols., sq. ft..	27 cts.	75 cts.
Total cost	$35,000	$57,000

Growth of the Missouri Pacific.

IV.

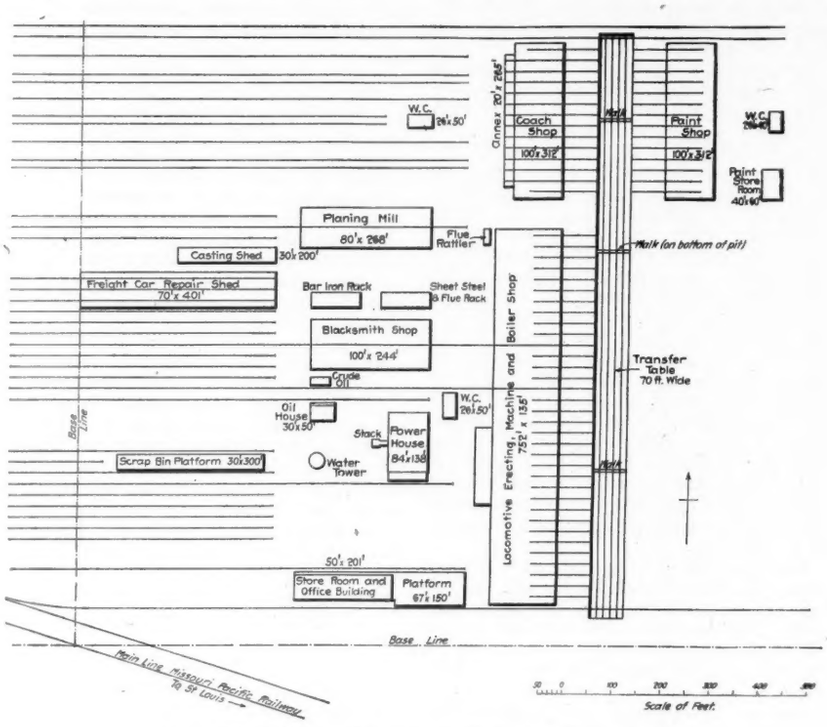
(*Continued from p. 327.*)

Ground was broken on May 10th of the present year for grading the site of the new general locomotive and car repair shops of the Missouri Pacific at East Sedalia, Mo. All of the preliminary work has been completed and work on the buildings is now in progress. The foundations are nearly completed, and the brick, steel and carpenter work has been contracted for. The grading contract was awarded to Henry Daumhoff, Little Rock, Ark.; the concrete contract to Edward Crebo, Kansas City, Mo.; the steel work to the American Bridge Company; and the carpenter work to Wyatt & Donovan, St. Louis. These contracts, with one exception, are for labor only, the railroad company furnishing all material on cars at the site. This departure from the usual method of doing such work is expected to result in a considerable saving to the railroad company. The exception noted is for the steel work, which will be furnished and erected by the American Bridge Company.

It will be seen from the general plan that the principal departments are ranged along one transfer table pit, the machine, erecting and boiler shops being combined in one building. The power station is to the rear of, and close to, the latter, as is also the blacksmith shop. The planing mill is about midway between the coach shop and the freight car repair shed. The storehouse has been located to procure the best track facilities and has a track on each side. The space opposite the locomotive shop is reserved for future extensions. The dimensions of the principal buildings are as follows: Erecting, machine and boiler shop, 752 ft. x 135 ft.; smith shop, 244 ft. x 100 ft.; coach shop, 312 ft. x 120 ft.; paint shop, 312 ft. x 100 ft.; planing mill, 268 ft. x 80 ft.; power house, 134 ft. x 84 ft.; freight car repair shed, 401 ft. x 70 ft.; office and storehouse, 201 ft. x 50 ft.

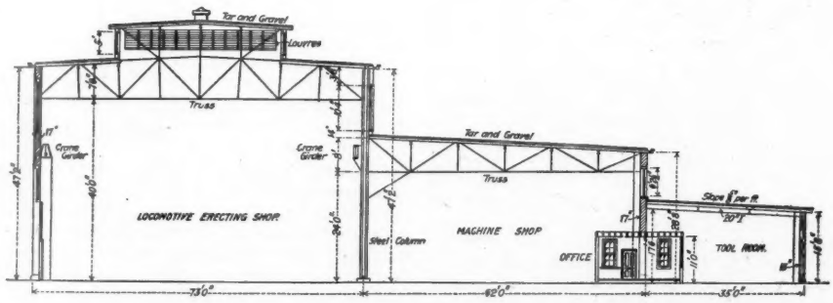
In designing the buildings, particular attention was given to uniformity of details, especially in the matter of doors and windows. The locomotive door used is the same for all the buildings, and is a special design made by Mr. Schaub. The size of the glass in all windows is the same for all shops—16 in. x 18 in. The walls of all buildings are brick, on concrete foundations, and all roofs have steel trusses with steel purlins. The jack rafters are 4-in. x 6-in. southern pine, and on them is laid 2-in. planking. Above this is a layer of asbestos roofing paper, then a layer of 1-in. tongued and grooved plank, and finally a five-ply, felt and gravel roof. All down-spouts are made of 4¾-in. well casing, and all flashing, ventilators, etc., are to be of zinc instead of the usual galvanized iron. The gutters on all buildings are a part of the roof proper. They are made of wood and covered with felt and gravel, the same as the roof. The freight car repair shed is open at the sides and ends and the roof is supported by 8-in. x 10-in. posts resting on concrete piers.

Locomotive Shop.—The erecting, machine and boiler shops are combined in one building. It is a transverse shop with 34 doors opening to the transfer table. Ten pits are intended for the boiler shop and 24 for the erecting shop. These pits are to be served with one 70-ton electric traveling crane, which is equipped with power for hoisting only; and by one 15-ton electric traveling crane for general service which will also be used for moving the 70-ton crane. The main erecting shop has a 70-ft. span and a height of 40 ft. from the floor to the bottom chord of the roof trusses. There is a large lantern in the roof with glass in the sides and louvre ventilators in the ends. There are no skylights in any of the buildings, so that all light must come from the sides. On one side the run-way girders for the traveling cranes are supported on pilasters on the building wall, and on the other side they rest on steel brackets secured to the main columns. The machine shop bay of the building is 62 ft. wide and 24 ft. high to the roof trusses. There will be no traveling crane in this shop, but heavy tools will be served by jib cranes. The tool room, air-brake room and tin shop will occupy a lean-



General Plan of New Shops at Sedalia, Missouri Pacific.

Part Side Elevation of Erecting and Machine Shop.



Cross-Section through Erecting and Machine Shop and Tool Room.

to, 160 ft. long and 35 ft. wide, alongside of the machine shop. The boiler shop riveting tower will be covered with cement plaster both inside and outside. All lantern walls in all the buildings are also to be covered with cement plaster.

Power House.—The power house is separated transversely into a boiler room and an engine room, each 49 ft. 5 in. wide, with a pump room 20 ft. wide between. Brick partition walls 13 in. thick separate the pump from the other rooms, and support the inner ends of the roof trusses spanning the boiler and engine rooms. The floor of the building is 5 ft. above grade, and a basement having 7 ft. headroom is below. The floor of the basement consists of 7 in. of granitoid laid over 8 in. of sand filling, while that of the building is concrete laid on I-beam supports. The entrance stairs of the building are concrete. The engine room will be served by a 15-ton hand-power traveling crane. The boiler room has a lean-to, 16 ft. wide, for coal storage, coal being delivered from a trestle by gravity through the door openings. The chimney will be 175 ft. high and 7 ft. inside diameter, and will be built by the Alphons Custodis Chimney Construction Company. The contract for the power house equipment has not yet been let. There will be, however, five 260-h.p. water-tube boilers, furnishing steam at 150 lbs. to three Corliss compound non-condensing engines, and one high-pressure engine. The generators will deliver direct current at 245 volts to the switchboard. There will be three 200-k.w. units and one 75-k.w. unit, which will furnish approximately 1,000 h.p.

Other Buildings.—The blacksmith shop is 244 ft. long and 100 ft. wide. The clear height to the roof trusses is 22 ft. There are no columns in the building, the trusses making a clear span from wall to wall. A large lantern with louvre ventilators extends nearly the full length of the building. The louvres are arranged so that they can be closed in case of severe weather. This building will have a cinder floor.

The planing mill, which is 268 ft. x 80 ft., has a clear height to the roof trusses of 21 ft. There is no lantern and the only openings in the roof are for the 24-in. ventilators. There is a standard-gage track through the center of the building.

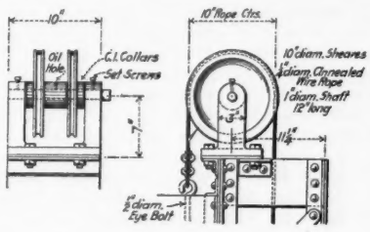
The coach and paint shops, on opposite sides of the transfer table, are both 312 ft. long, the former being 120 ft. wide and the latter 100 ft. They are three-bay buildings with steel, roof-supporting columns. The coach shop is two stories, the second floor being intended for upholstery and general repair work for coaches. There is a lean-to 22 ft. x 265 ft. on the west side, for a truck repair room, an 80 ft. car not allowing sufficient room in the main building for this work. There are stalls for 14 cars. The paint shop is of equal capacity, and has a concrete floor.

The freight car repair shed, already briefly described, is built of wood, and is open all around to a height of 8 ft. There are three longitudinal tracks, giving about 1,200 ft. of track space.

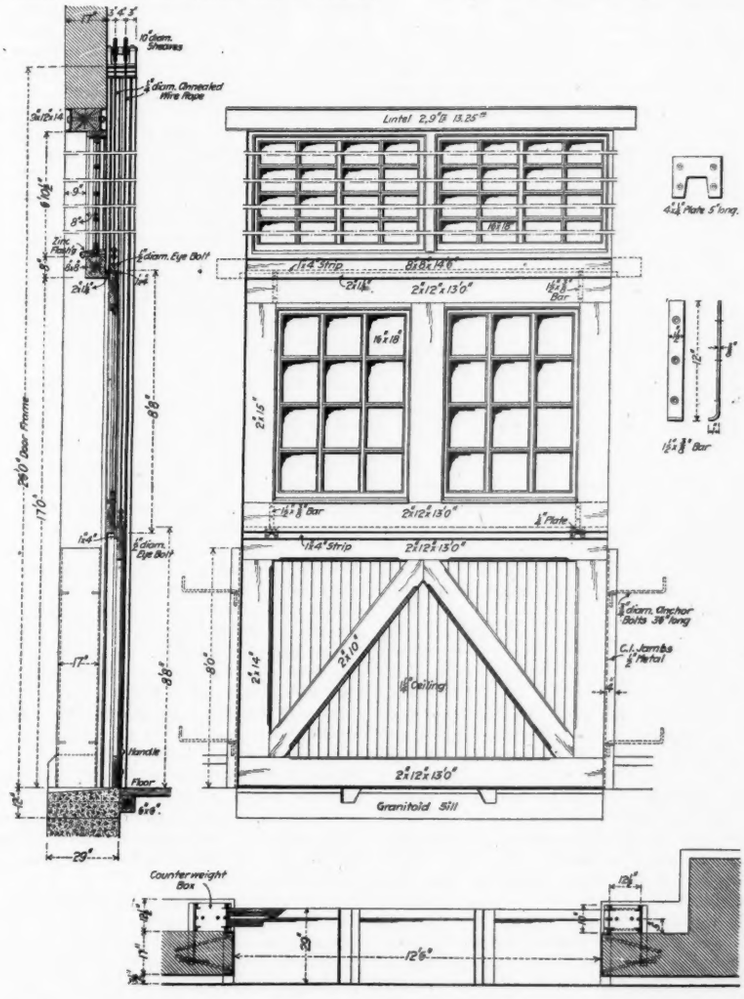
The storehouse and office building has three floors and a basement. The top story is quite low and is intended principally as an air space to improve the comfort of the offices on the second floor. The upper floors and the roof are supported by steel columns, there being a double row running longitudinally through the building. The first floor is carried on 20-in. 65-lb. transverse, and 15-in. 42-lb. longitudinal I-beams, the second floor on 10-in. 25-lb. I-beams, and the third floor on 9-in., 21-lb., I-beams. The floors are all dressed and matched plank, 2¾-in., 2½-in. and 2-in. respectively for the three floors of the building, secured to 3-in. x 8-in. nailing strips. A part of the building will be fitted up for offices for the mechanical department. The floors of all buildings not otherwise specified are 3-in. plank laid on 6-in. x 6-in. sleepers bedded in sand on cinders.

A detail of the locomotive door which will be used on all the buildings is shown in one of the accompanying drawings. It is made in two parts which are hung with separate counterweights and are raised vertically like window sash. The top sash has two window lights each made up of 12 panes of glass, 16 in. x 18 in., and the bottom sash is made with a single panel of matched cypress. Where these doors occur in long buildings, they are provided with a narrow wicket so that the building can be entered without raising the large doors. The two top and bottom sash are arranged with stop lugs so that the bottom sash engages the top sash when the former is raised half the height of the door, and both parts are then raised together to the full door opening. In closing the door the bottom sash is lowered first and when it has been pulled down half-way it engages with the top sash and both halves are lowered the rest of the way together.

Mr. E. Fisher, Engineer of Bridges and Buildings of the Missouri Pacific, has the supervision of the entire work, and all plans, etc., are submitted to him for approval. Mr. J. W. Schaub, Consulting Engineer, Chicago, has prepared all plans, specifications and bills of material for the buildings and power plant, and has charge of the entire work as consulting engineer for the railroad company. We are indebted to him for the accompanying drawings of the buildings and these notes concerning them.



Detail of Counterweight Sheaves.



Locomotive Door for All Buildings.

The Ganz and Finzi systems of alternating current traction will shortly be given competitive trials on the Valtellina branch of the Adriatic Railroad. One of the electric storage battery motor-cars of the Bologne-Modena branch of the railroad will be rebuilt and the experimental storage battery equipment will be replaced by a Finzi single-phase alternating current equipment. Four single-phase geared motors of 100 h.p. each will form the equipment. Step-down transformers will reduce the line voltage to 3,000. The maximum speed expected is 72 kilometers an hour and trains of 100 tons will be hauled. The storage battery cars of the Milan-Monza line have been withdrawn from service, after trials extending over four years.

Traffic on Improved Waterways and Railroads in the United States.*

BY EDWARD P. NORTH, M. AM. SOC. C. E.

In one great source of national wealth, cost of transportation, which is not a natural product, the United States has an undisputed advantage over all other countries. Shortly before his death, Mulhall said that the average rate received by railroads of different countries for transporting a ton of freight one mile was, reduced to cents: United Kingdom, 2.80; Italy, 2.50; Russia, 2.40; France, 2.20; Germany, 1.64; Belgium, 1.60; Holland, 1.56; United States, 0.8. These figures show that our low cost of internal transportation has been the principal cause of our augmented wealth; an augmentation that was greater in the decade ending with 1900 than during the 80 years preceding 1870. For not only does a low freight rate allow more to be divided between producer and consumer, but it has a more potent effect in inviting the production of commodities which with higher freight charges could not reach consumers; thus adding greatly to the employment offered to labor and capital.

Any estimate of the beneficent effect of low freight rates on production is as liable to be governed by enthusiasm as by knowledge. Table 1, compiled from "Poor's Manual," the United States Census returns, and those of the Bureau of Statistics, shows the direct contributions made by our railroads to the wealth of the nation. The highest freight rate during this period was, in 1885, 1.057 cents, and the lowest, 1899, 0.726; since which time the rate has increased by about 5 per cent. to 0.764. If our rates had remained as in 1885 we would have paid $3,500,000,000 more for transporting our freight than we did, and if our freight rates had been equal to those of England, as stated by Mulhall, and with as large a volume of business possible at such rates, the cost would have been nearly $33,000,000,000 greater, or more than our increase in wealth during the last decade. Our railroad freight rates are the lowest in the world, and this is probably true also of our coastwise freight rates. The low cost of assembling and distributing our commodities has also had an important influence on their production and consumption.

TABLE I.—RAILROADS OF THE UNITED STATES.

	Per annum			Average	Per ton-mile		An'l paym't
Years.	Tons of freight shipped.	Ton-miles.	Freight earnings.	Haul, miles.	Freight earnings, in cts.	Per capita.	for freight, per capita.
1885-89	536.0	60,523.0	602.4	113	0.995	1.031	$10.26
1890-94	717.4	83,524.6	764.0	116	0.915	1.283	11.73
1895-99	841.6	104,371.0	817.2	124	0.783	1.457	11.41
1900-02	1,116.0	148,915.0	1,125.0	133	0.755	1.918	14.49

NOTE.—Figures in 2d, 3d, and 4th columns should be multiplied by 1,000,000.

It is noticeable that we have reached this distinctive position as transporters with the highest wages paid for labor known, and until lately with a higher cost for materials than our neighbors and competitors. But both the high wages and high prices have, by stimulating production and consumption, added to the volume of freight moved and reduced its cost.

We have had, until lately, freedom from those laws based on the theory of vested interests which are used both to prevent improvements and solidify monopolies, while our development has been aided by subsidies of various kinds from both State Governments and the General Government, to which local aid has often been added. Since our organization as a nation we have been pre-eminent for the energy and persistence with which we have developed and improved such aid to our wealth as is offered by water transportation. Improvement of the Mohawk west of Schenectady, the precursor of the Erie canal, commenced with the adoption of our constitution, and concurrently the navigation of many streams falling into the Atlantic was improved and extended. Our canal-building era was virtually inaugurated by the building of the Erie canal connecting the navigable waters of the Hudson river with all of our Great Lakes under legislation by the State of New York in 1816. The great influence on land values of this canal after its completion in 1825, and its success as a channel for transportation, led not only to more or less successful efforts to connect the James, the Potomac, the Delaware and the lakes above Niagara with the affluents of the Mississippi, and to many less important projects, but also to such an enlargement of the Erie canal, authorized in 1835, so that the burden of boats could be increased from 40 to 240 tons.

The net area of lands granted by Congress to States, Territories and Corporations has been: In aid of railroads, 162,000,000 acres; in aid of canals, 4,433,000 acres; in aid of wagon roads, 2,554,700 acres; 168,987,700 acres in all.

On the 6th of April, 1802, the United States entered on its policy of River and Harbor Improvements with an appropriation of $30,000 for the improvement of the Delaware river. Up to March 3, 1903, the sums appropriated on this account have reached the aggregate of $451,344,907.20. During the 58 years ending with 1860 but a little more than $16,500,000, or less than 4 per cent. of this sum, had been appropriated. Taking the appropriations for these improvements by decades we have:

1861-71	$17,290,445.80
1871-80	60,440,417.96
1881-90	111,687,724.36
1891-1900	175,372,564.22
1901-March 3d, 1903	70,067,231.24

Approximately 55 per cent. of this sum has been expended on the improvement of rivers, 35 per cent. on harbors and 10 per cent. on canals. The total expenditure by the Government for all harbors and waterways on the lakes above Niagara has been $68,000,000. Of this sum probably about $40,000,000 has gone to lake harbors.

Excepting a few instances, and then but for a short time, the rivers, harbors and canals improved and built by our Government have been absolutely free from charges for their use. While a large proportion of the money expended for improvements has gone to important centers, and the main lines of distribution minor streams and small harbors have not been neglected.

Trunk line railroad building in the United States was inaugurated at "a meeting of a number of citizens to take into consideration the best means of restoring to the City of Baltimore, that portion of the western trade, which has lately been diverted from it by the introduction of steam navigation, and by other causes," held in the City of Baltimore, Feb. 12, 1827. This meeting resulted in a charter for building a railroad from Baltimore to the Ohio river. At substantially the same time, May, 1828, Congress appropriated $1,000,000 in aid of the Chesapeake and Ohio canal, which was also to connect the waters of Chesapeake Bay with the Ohio. The Hudson & Mohawk Railroad, which has developed into the New York Central & Hudson River Railroad, was built to abridge the delay to canal traffic caused by the 22 locks between the Hudson river and the Schenectady level of the Erie canal. The Boston & Albany was built to divert trade at the eastern terminus of the Erie canal from New York to Boston. The South Carolina road was projected to connect the harbor of Charleston with the Ohio at Cincinnati.

The first roads were built under special charters, which were generally obtained without difficulty, except in such cases as the Pennsylvania's objection to the Baltimore & Ohio reaching Pittsburg, on the honest plea that there could not be traffic enough for two roads. The menace to invested capital, now so strenuously insisted on, is a doctrine hardly 25 years old with us. Afterwards the more enlightened States passed general railroad laws, under which any persons filing the requisite papers became a body corporate, and could make the necessary surveys, and build as much road as they could finance. Only one State, New York, ever penalized a railroad. The Utica & Schenectady, now a part of the New York Central & Hudson River Railroad, was for a time prohibited from carrying freight, whether the canal was closed by ice or not, and the railroads which formed that system paid canal tolls to the State on all freight carried until 1851.

The Government of the United States gave a great impetus to railroad building by its legislation of Sept. 20, 1850, giving to a trunk line railroad between Lake Michigan and the Gulf of Mexico, substantially, six square miles of land for each linear mile built. This aid was so continued that every State and Territory west of the Mississippi and five States east of it, viz.: Alabama, Illinois, Mississippi, Michigan and Wisconsin, are indebted to land grants, in a greater or less degree, for their transportation facilities. In aid of the Texas Pacific the land grant was 40 square miles, through the territories, per mile of road. The Union and Central Pacific Railroads, with some of their branches, in addition to a land grant of 20 square miles per mile of road, amounting to nearly 32,000,000 acres, secured a loan of Government 6 per cent. 30-year bonds, varying with the difficulty of construction from $16,000 and $32,000 to $48,000 per mile. This loan was in the aggregate $62,652,952, of which the Union Pacific received $27,236,172 and the Central Pacific received $25,885,120. These loans were repaid with outstanding interest about 1898, excepting a small default on the part of one of the branch roads. This combined aid was sufficient to induce the Union Pacific to build 535 miles in one year and 20 days.

The British Government in 1853 subsidized its main lines of steamers "to afford a rapid, frequent and punctual communication with those distant ports which feed the main arteries of British commerce, etc."; refusing aid to, if not oppressing, internal communication. On the other hand, the Government of the United States, and also individual States, counties and localities, subsidized the turnpikes, watercourses and railroads almost entirely for the improvement of internal communications, and neglected or oppressed our efforts to reach distant ports. England is pre-eminent as a shipbuilding and ship-sailing country, but its people pay the highest internal freight rates known. America now has a contemptible merchant marine, but its internal freight is handled at a rate unapproached in other countries. If, as has been lately urged, our Government was unable to develop at one time both foreign and internal communica-

*Extracts from a paper read before the International Engineering Congress, at St. Louis, Oct. 5, 1904.

tions, it has apparently adopted the most profitable alternative, although our annual payments to foreigners for over-sea freights are said to exceed the receipts from either custom dues or the internal revenue tax.

While the land subsidies granted by the Government in aid of turnpikes, canals, colleges, etc., have not generally hurried the lands granted into cultivation, it is noticeable that in the case of land granted to railroads the recipients have had a financial interest, strong enough to be a governing interest, in its quick distribution in small holdings, as the possible ultimate value of the land is secondary to the development of traffic on the road. The Immigration Bureau is greatly aided in its efforts by low freight rates. As the cost of transportation is vital in the eyes of the prospective buyer, its cost has been kept down on non-competitive branches. The beneficent results following the practices of the land-grant aided railroads have not, however, prevented the "friends of the plain people" exhibiting fierce opposition to the development of our unsettled areas through the aid of land grants or other forms of subsidies.

The free development of railroad building and the fall in freight rates have been impeded to some extent by the action of State Railroad Commissions. The first of these, for the State of Maine, was appointed in 1853. There are now 34 of these commissions. At first their action was doubtless beneficent, but in some States the appointment of commissioners seems a perquisite of the railroads, and, as notably in the State of New York, it seems virtually impossible for an oppressed community to secure better accommodations or lower rates by investing their own money in a railroad which may reduce the profits of an existing line, all such efforts being apparently held by the commissioners, as well as the stockholders of existing lines, to be a piratical venture and a speculative strike of more or less colossal magnitude. The railroads of New England, dominated by the most respectable and highly appreciated Commissions, exact the most onerous charges on traffic known in this country, and have driven nearly all heavy manufacturing out of their territory.

A considerable amount of the 451 million dollars appropriated by the Government for the improvement of rivers and harbors, has been expended on isolated or semi-isolated projects, where the statistics covering the consequent development of traffic are not available without great research. In other cases like the 18,500,000 net tons of freight traffic found 12 years ago on the Hudson river, or the 11,610,000 tons of freight carried on 11 improved tributaries of the Ohio in 1902, as reported by the Department of Commerce and Labor, no idea of the cost of freightage is given. Nor are the rates charged on the total traffic of the Great Lakes given in the report of the same department, which gives the average arrivals and departures in domestic trade for the two years 1902-03 for which statistics have been gathered as 74,390,000 and 74,340,000 net tons of freight. During the same two years the average imports of foreign merchandise at these lake ports have been valued at $61,187,000 and the exports at $88,076,000.

As the natural depth at most harbors on the Great Lakes was originally about 6 ft., and not more than 8 ft. could be carried over the St. Clair Flats, above Detroit, this large traffic would be impossible without the increased depths made by the expenditures authorized by the various river and harbor bills. The first appropriation, 1823, was for the harbor of Erie. Ohio followed in 1825 with appropriations for Cleveland and Fairport. Buffalo did not get an appropriation from the Government until 1826, Chicago in 1833, and the St. Clair Flats received its first appropriation, $20,000, in 1852.

In 1852, Congress gave the State of Michigan 750,000 acres of public land in aid of a canal connecting Lake Superior with Michigan, Huron and Erie. This canal, built for the State by an incorporated company to which the land was transferred, was opened June 18, 1855, with two locks of 9 ft. lift, each 350 by 70 by 11½ to 12 ft., to overcome the 18 ft. difference of level at the Falls of St. Mary, or, as it is generally known, the "Soo." The Government took over this canal from the State of Michigan, June 9, 1881, and completed the "Weitzel" lock, 515 by 80 by 17 ft., Sept. 1, 1881, and the "Poe" lock, 800 by 100 by 22 ft., August 3, 1896. The Canadian Government had in the meantime built a lock 900 by 60 by 22 ft., opened Sept. 9, 1895. The depths of lake channels, in general, have been less than the depths on the lock sills. Tolls amounting to $778,128.41 were collected on the 19,414,242 net registered tons of shipping passing through the canal in the 26 years, including 1880, that the canal remained State property. They were 6 cents per net registered ton until 1871, 4½ cents until 1879, and after that 3 cents. Since 1880 the traffic through both the American and Canadian locks has been free.

Since 1887 the U. S. Engineers in charge of the canal, with the co-operation of those in charge of the Canadian Canal, have kept and published statistics which are among the most valuable in the history of transportation. From these data Table II has been compiled.

TABLE II.—Freight Tons Passing the Soo.

Year.	Tons.	Total value.	Value per ton.
1851.....	12,600	$1,675,000	$133.00
1861.....	88,000	6,000,000	68.00
1871.....	585,000	13,000,000	22.00
1881.....	1,568,000	30,000,000	19.00
1891.....	8,889,000	128,000,000	14.50
1901.....	28,403,065	289,916,865	10.20
1903.....	34,674,437	349,405,014	10.08

The Engineer Officers' statistics of the traffic through the "Soo" show that the difference on an equal classification between the actual and railroad charges is nearly four times the total expenditures for river and harbor improvements by the Government.

As only 41½ of the 958¼ miles between Duluth and Buffalo have required improvement to accommodate vessels of 20-ft. draft, and the same improvement has sufficed for the 885 miles between Chicago and Buffalo, the combined traffic on these routes being without an equal in any other channel, no other improvement undertaken by our Government has had so beneficent an effect on our national wealth, nor has returned so large a dividend on the money expended.

It is not proposed to refer to the economies, many of them calling for large expenditures, by means of which our railroads have become the chief of the labor saving appliances, not only of this country but of the world. But aside from the influence of our, one time, free railroad building, these economies have in almost all instances been forced on our railroad managers by the competition of improved waterways; which, while their traffic fed, and was fed by, the railroads, cut rates to an extent that called out extreme effort in the attempt to compete on a paying basis. This competition has resulted in our being able to produce and ship a third more freight per capita, despite our longer haul, than any other people, and has filled our country with consumers, who, as James Bryce says in his "American Commonwealth," "allow themselves luxuries such as the masses enjoy in no other country." And the traffic in luxuries as well as in passengers is generally transported by rail.

There has been one noticeable instance in which the railroads led in improvements to waterways, forcing the deepening of the lake channels. This was a consequence of the rate wars of the seventies, which covered much of the United States, but were most intense between the roads connecting Chicago with New York. Under this rivalry the lake commerce seemed to be dying. The situation at that time is tersely and ably described in the "Report of the Committee on Canals of New York State, 1899," made to Governor Roosevelt. It says:

"In 1875 the total tonnage on the lakes was nearly 600,000 tons. . . . The traffic, as estimated by entrances and clearances at American ports, was for that year about 15,000,000 tons.

"This development had, however, been secured without any material increase in the size of the vessels in use—a limit being placed on size by the depth of water in the harbors and in the channels connecting Lake Erie and Lake Superior with Lake Huron and Lake Michigan. By 1875 the advance in railroad construction and management had reached a point which enabled the railroads to compete with the lake vessels; and when to this was added the railroad rate wars of the next few years there was not only a cessation of increase in lake commerce, but a positive decline both in equipment and traffic. New construction of vessels, which had reached as high as 73,000 tons in 1874, was only 7,000 tons in 1877, and averaged only 13,000 tons a year for the five years ending in 1880. In the latter year all the vessels on the lakes aggregated only 560,000 tons, 30,000 less than five years before.

"The beginning of the new decade marked a significant revival in lake commerce, which cannot be disconnected from the improvements in lake harbors and channels undertaken by the national government. The most important work brought to completion at this time was the openinng of the ship canal with an 18-ft. draft, which took the place of the 12-ft. canal and locks maintained by the State of Michigan at Sault Ste. Marie, but other works were well under way, which have had for their ultimate aim the securing of 20 ft. of water in all the main channels and important harbors on the lakes."

If the existence of the lake business as well as the lake marine, had not been threatened by the development of improved methods of conducting railroad traffic, it may be doubted if Government would have received sufficient support to justify it in entering on the heavy expenditures necessary for navigable channels 18 and eventually 20 ft. in depth. There is always available such testimony as was given in 1870, by one prominent in lake commerce:

"It had been clearly established that vessels of over 700 or 800 tons were not so profitable on the lakes as vessels of a smaller size. Nature has placed barriers in front of most of our harbors, also wide flats across some of our greatest thoroughfares, that will, in spite of art, for ages to come, make it necessary to build lighter-draft vessels. Sail vessels of over 800 tons could not safely navigate the lakes even if harbors were deep enough."

Such testimony, by an authority, is always available and influential in procuring delay and insufficient improvements unless there is a strong interest capable of organization to confute it. And as the nearly accomplished improvement has resulted in 19 vessels, carrying over 8,000 net tons each,

passing the Soo last year, the testimony seems confuted.

The United States possesses no noticeable superiority in natural resources, and is handicapped by the necessity of finding money to do in a part of a century that for which other countries have taken nearly a thousand years. It has in the aggregate exhibited a superiority in general honesty of purpose and in the broad-mindedness of its legislators, both national and local. It is largely through legislation, notably and peculiarly in its help to all schemes for increasing wealth by diminishing the cost of interchange between producers and consumers, that this country has attained its superiority. From the fairly equal distribution of subsidies and direct payments between waterways and railroads, there has issued a system of mutually beneficent rivalry, in that the railroads often own boat lines and the boat lines have owned railroads, which has given a higher remuneration to the producer, and a lower cost to the consumer, than would have been possible under any other system.

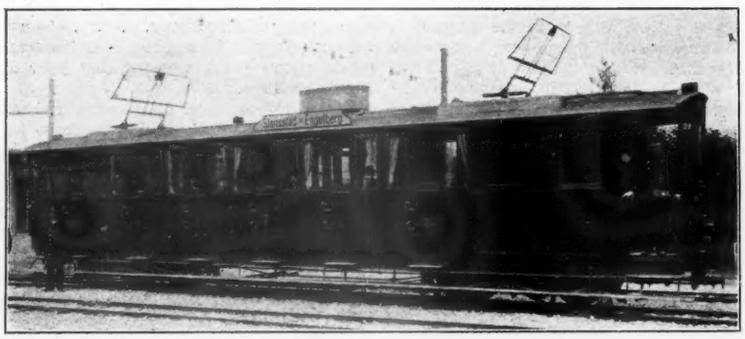
As a result our internal commerce for 1902 is estimated at $20,000,000,000. This estimate is based on one transaction in each of the leading classes of commodities produced in the several different divisions of national industry. Our foreign commerce amounts to nearly 12 per cent. of this sum, and 6.8 per cent. of it suffices to settle our foreign balances, and pay for our foreign transportation with such luxuries and raw materials as we require from other countries.

Exclusive of the benefits derived from land grants, there seems to be no reason why any other country should not develop its transportation systems in a manner analagous to that pursued by the United States and reap as substantial a reward.

The Stansstad-Engelberg Electric Railway.

BY EMILE GUARINI.

The narrow-gage electric railway between Stansstad and Engelberg is another of those electric-mountain roads of which Switzerland furnishes so many interesting examples.



Motor Car—Stansstad-Engelberg Railway.

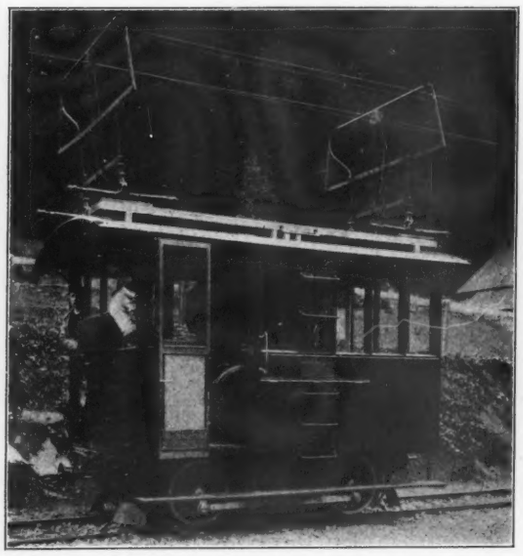
A Transformer Sub-Station.

The road was built by Brown and Boveri, and has a length of 22½ kilometers. The current is transmitted in the form of a three-phase current of 750 volts, one of the phases being connected to the rails which are laid one meter apart. A distinguishing feature of this mountain line is that, although the grades vary from level to 5.8 per cent., the car is at times propelled by its own motor, at other times it trails motorless cars behind it, and again the train is drawn by locomotives at the points where the grade is the heaviest.

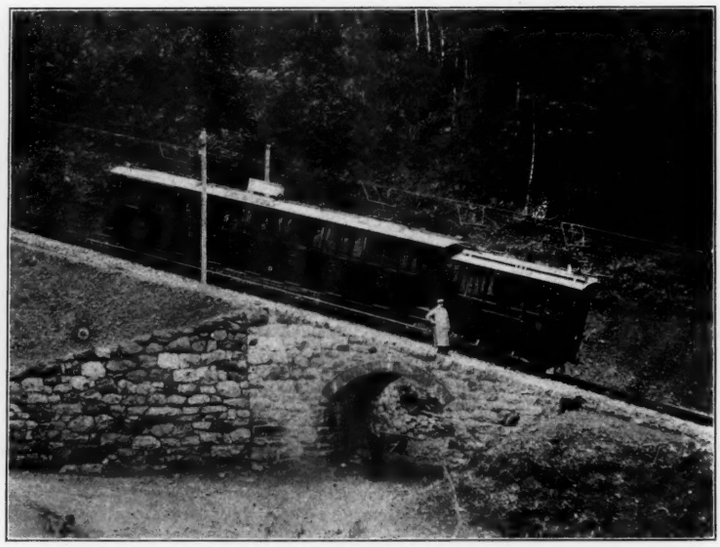
Over a distance of 21 kilometers the ordinary adhesion of the car to the rail furnishes sufficient traction; for 1½ kilometers, however, a rack and an extra engine is used. The rack section is close to the central power station, and since it requires the greatest expenditure of energy, it receives the triphase current at 750 volts direct from the alternators. For the rest of the line the current from the alternators at 750 volts is transformed into a current of 5,300 volts, whence it is sent out on the high tension line to be stepped down again by two transforming stations to 750 volts, the working tension. The central or generating station is at Obermatt, near the terminal point at the Engelberg end.

The power is obtained from several springs which feed a covered reservoir of about 100 cu. meters capacity. A conduit 1,634 meters long leads from this reservoir to the turbine house. For about 230 meters, cast-iron pipes, 300 millimeters in diameter, having a thickness of from 7½ to 8½ millimeters, are used. The effective fall is 390 meters. The power-house, to which is annexed a barn for the locomotives and a repair shop, contains three generators and two exciters. Each of these machines is coupled direct to a horizontal axle water turbine. The three groups of electric generators are 180 h.p. each and run at 650 revolutions, while the exciters are 12 h.p. each. The large turbines are regulated by hydraulic governors. The exciter turbines, on the contrary, have no governors, for the load of the exciters is kept constant by a compensating resistance in the field circuit of the generators. The exciters and generators are coupled in parallel. A special apparatus is provided, which, in case a high tension wire should break, cuts out automatically the exciters from the dynamos.

A sub-station is at Dallenwyl and at Stans. The line starts from the steamboat landing at Stansstad and runs on a level as far as Stans. After leaving Stans the line turns toward Oberdorf, whence it follows the left bank of the Aa, which it crosses beyond the station of Dallenwyl by means of a bridge 35 meters long; from here it runs to Grafenort by way of Wolfenschissen. At this



Three-Phase Electric Locomotive.



A Steep Grade on the Stansstad-Engelberg Railway.

point the road ascends a grade of 5 per cent. Upon a viaduct the line now crosses the Kaltebach and comes into Obermatt, where the cog-wheel section begins and runs along for 1½ kilometers over a 5 per cent. grade. In the middle of this rack ascent is the station of Grünenwald; immediately after leaving this station the line cuts the cantonal highway which crosses it about one meter above the rails. Since both the roads have curves at their point of crossing, it did not seem feasible to have a grade crossing, especially since there is extensive teaming on this cantonal highway and there was fear that the proper maintenance of the rack would be made difficult. On the other hand natural characteristics did not permit the cheap building of a tunnel or cut. Under these conditions the only feasible plan was to build a lift bridge, which was finally done. The construction of the lift bridge was difficult because the contact wire must be elevated to a great height above the highway and also above the level of the rails which are below the road. It became necessary to use a system that would permit the elevation of the contact wire sufficiently to allow the passage of vehicles of all sizes as well as to arrange the parts so that the opening of the bridge should automatically lower the contact wire into a position that would permit the passing of the train. The bridge is worked entirely by hand, the opening of the bridge and the lowering of the contact wire requiring no more than a minute.

From Gherst, at the terminus of the cog road, the track runs over an easy grade to Engelberg. Much blasting was needed for the completion of this section of the road on account of the rocky nature of the ground, and not infrequently sustaining walls, several hundred meters long, had to be built.

The rails are the Vignolle type, 10½ meters long, and weighing 20 kilogrammes per meter. They rest upon iron ties that weigh 30 kilogrammes each; eleven of these ties per rail are laid except on the rack section, where 12 to a rail was found preferable. The rack is of trapezoidal form and is made of two parallel plates between which are riveted the cast steel teeth. It weighs 52 kilogrammes per meter and is laid in segments, each 3½ meters long. In order to insure the meshing of the cog-wheels at the entrance of the rack, this latter is terminated by a segment resting upon springs and joined to the line in such a manner that it may be lightly depressed in a vertical plane.

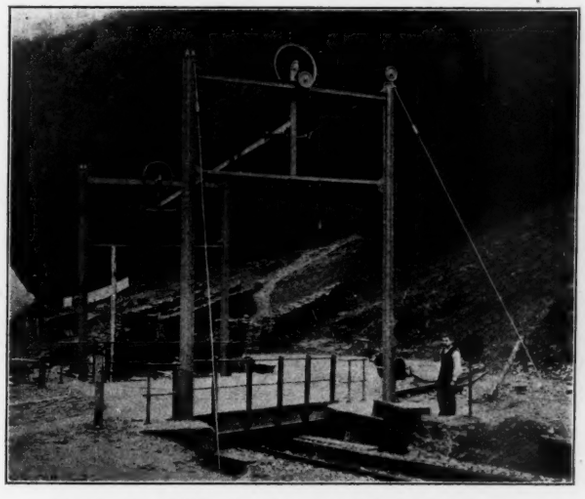
The buildings of the several stations are wood and brick. The stations are lighted electrically by means of small transformers fed from the trolley wires, and which reduce the tension to 110 volts. At Stansstad there is a barn for five motor cars, also a repair shop and a depot for materials and tools.

The entire line is divided by section insulators into five divisions which are independent of each other, being fed separately. Between the feeders and the trolley wires are fuse blocks which act as interruptors. These fusible cut-outs are placed in metallic boxes on poles. The feeders, which are formed of two copper wires 7½ millimeters in diameter, have a total length of 4,200 meters, and are carried on porcelain insulators attached to the trolley poles. The high tension line consists likewise of two wires, but they are only 3½ millimeters in diameter and extend over 11 kilometers. They are supported upon another line of poles. These poles are eight meters high and are, for the most part, placed close to the track, at a distance of 80 centimeters from the trolley poles, being braced by struts outside of the track. Wherever the high tension line crosses highways or above lines of telegraph, telephone or trolley wires, they are surrounded with net work in order to avoid any accident that might arise from the breaking of one of them. Upon the caps that cover the trolley-wire poles is carried the telephone line, which is composed of two silicious bronze wires 2 millimeters thick, having cross connections at about every 100 meters. The high tension line is protected from lightning by horn lightning-arresters, while for the trolley wire the Westinghouse lightning arresters have been adopted. In the neighborhood of Stans the three-phase current line crosses the Stansstad-Stans tramway, which is operated by direct current, so that a special arrangement for the crossing as well as for the ends of the trolley or contact poles was necessary.

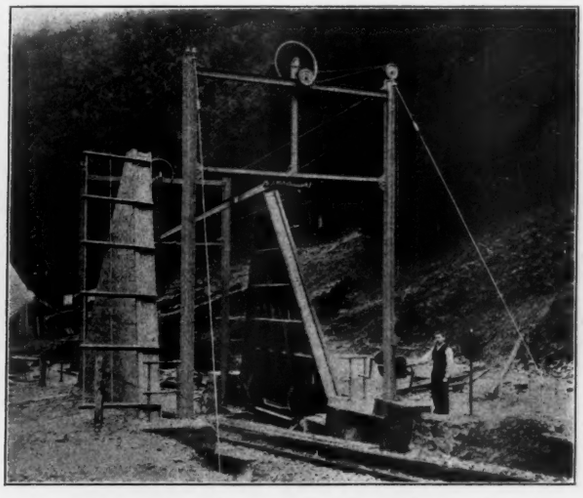
The locomotives weigh about 12 tons. They have two three-phase motors of 75 h.p. each, wound for 750 volts and making 650 r.p.m. These motors weigh two tons each. Both motors work in common upon a single toothed wheel keyed upon an intermediate

A Level Portion of the Stansstad-Engelberg Railway.

Beginning of Rack Road at Overmatt Station.



Lift Bridge (Closed)—Stansstad-Engelberg Railway.



Lift Bridge (Open)—Stansstad-Engelberg Railway.

shaft, which communicates its power by a simple train of gears to the axle carrying the cog which engages the rack. Upon the stretches where simple adhesion to the track is sufficient, a friction clutch allows the motors to work direct upon the axles. The speed of the locomotives is five kilometers per hour on the cog-wheel section and twice that upon the other sections. Three entirely independent systems of brakes are available for stopping the locomotives. They are: (1) A hand brake bearing directly upon the supporting wheels. (2) A hand brake acting upon the cog-wheels. (3) An automatic speed limiting brake. This brake may be controlled by the hand of the motorman on the locomotive, or by any of the motormen on the train. This brake is constructed in such a manner that when a certain determined speed limit is exceeded the flow of the current is automatically interrupted and at the same time the brake bearing upon the cog-wheels is brought into action. Moreover, the motors act as automatic brakes, whenever the down grades are such that the speed of the motors exceeds more than about 4 per cent. of the normal speed during the ascent. The contact device consists of two double bows which are fixed upon the roof of the locomotive by means of two frames furnished with spring tighteners. The lighting current is obtained from small transformers.

The motor cars are mounted upon two four-wheel trucks. Their length is 14 meters and they weigh 14 tons. They are divided into second and third class compartments, affording seats for 46 persons; and also have a small compartment for baggage. On the axles of the forward truck two three-phase motors of 35 h.p. each are mounted. They are wound for a tension of 750 volts and make 480 r.p.m. Each motor weighs 950 kilogrammes. A train of gears transmits the power to the driving wheels. The cog-wheels are cast steel and their lower peripheries run in an oil well. The rear truck is furnished with a brake that acts upon the cog-wheel. This has been installed as an auxiliary to the powerful hand brake. The current is taken from the contact wires in a manner similar to that described for the locomotives. The maximum speed is fixed at 20 kilometers an hour. Starting is made in a gentle, hardly perceptible manner. For lighting the car, a small transformer is in one corner of the baggage compartment, whereby the current taken from the line is reduced to 100 volts. The cars are heated by means of 14 heaters grouped in sevens and connected in series cut in between one of the contact wires and the rails. A motor car is capable of drawing a second car weighing 10 tons at the rate of 20 kilometers an hour, upon a grade of about 2.3 per cent. Upon those stretches where the gradients vary between 1.5 and 3.0 per cent. the cars run alone at about 20 kilometers per hour. When mounting the steep grades of 5.8 per cent. they require from 80 to 90 h.p. for a load of 16 tons. After leaving Obermatt the cars are pushed by one of the locomotives to the top of the rack road. On this run the car is not coupled to the locomotive, so that in case of accident either unit can act independently.

From Gherst, which is at the summit of the rack road, to the terminal station at Engelberg, the cars continue the journey unassisted. When the cars descend the steep grades the motors act as generators. The energy thus restored, and the load removed from, the generators at the central station would cause the turbines together with their dynamos to race, but to avoid this the dynamos may be loaded with liquid resistance, and for this purpose the spillway canal has been used. Trials have been made which show that, when a train of 28 tons descends the rack road, the energy restored to the central station equals 75 h.p. This energy, except where it is consumed in carrying a like train up the incline, must be absorbed by the liquid resistances and a little more if the generators are not to be permitted to run altogether light. Since the company controls a water power more than sufficient for its needs no provision has been made to automatically cut out this resistance when not required, consequently it is for the greater part of the time included in the circuit. This is an installation which does honor to Brown and Boveri, of Baden. The traffic from the Lake of the Four Cantons towards Engelberg is heavy, particularly in the summer season.

Railroad Shop Tools.

(*Continued.*)

RADIAL DRILLS.

The accompanying illustration, Fig. 1, shows a semi-radial drill made by the Bickford Drill & Tool Co., Cincinnati, Ohio. The head is a single casting and is adjustable on the arm by a spiral gear. The spindle is made of hammered steel; it is provided with both hand and power feed and with quick advance and return movements. The machine has three rates of feed ranging from .008 to .016 in. per revolution of the spindle. The driving mechanism contains seven gears by which five changes of speed can be obtained ranging from 50 to 170 r.p.m. The frame of the machine consists of five parts, the base, the column, the cap, the arm and the arm shaft. The construction of the bearing for the upper cone pulley is shown in the line drawing, Fig. 2. The general dimensions of the machine are:

Traverse of spindle	18 ins.
Horizontal range of head	3 ft. 6¾ ins.
Receives under spindle over table	24 ins.
Receives under spindle over base	4 ft.
Receives under spindle over floor	4 ft. 7 ins.
Drills work in plane of base of center of	8 ft.
Size of table, working surface	20 x 20 ins.
Size of base, working surface	3 ft. x 4 ft. 1 in.
Distance from floor to extreme height of spindle	9 ft. 4¼ ins.
Floor space required	9 ft. 3 ins. x 11 ft. 9 in.
Weight, net	6,500 lb

The 72-in. radial drilling machine, Fig. 3, is made by William Sellers & Company, Philadelphia, Pa. The spindle of this machine is 2½ in. in diameter and it has an adjustment of 17¼ in. The maximum distance from the center of the spindle to the center of rotation of the arm is 59 in. The greatest distance from the floor to the nose of the spindle is 67 in. The drilling-head arm has a power-vertical adjustment. The spindle is counterbalanced and is fitted with friction feed. The slotted work table is 24 in. square by 30 in. high. The countershaft pulleys are 10 in. in diameter by 4 in. face and should run at 110 r.p.m.

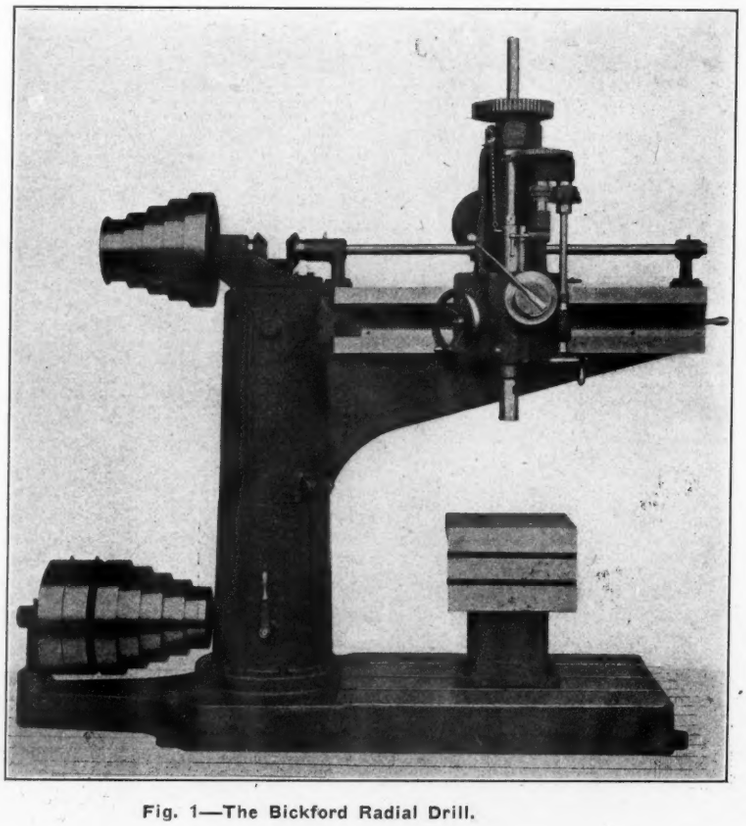


Fig. 1—The Bickford Radial Drill.

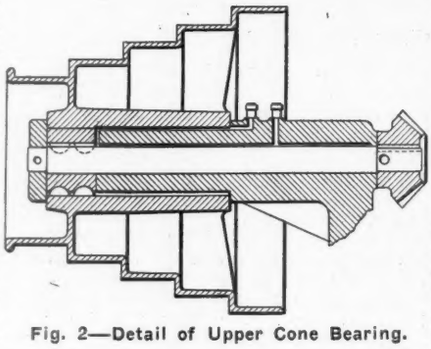


Fig. 2—Detail of Upper Cone Bearing.

The machine shown in Fig. 4 is a 6-ft. arm, plain radial drill made by the Fosdick Machine Tool Company, Cincinnati, Ohio. The column of this machine is of box section cast in one piece, and it is bolted to the base. The saddle which carries the radial arm is gibbed to the column, and is raised and lowered by power. The arm is of box sec-

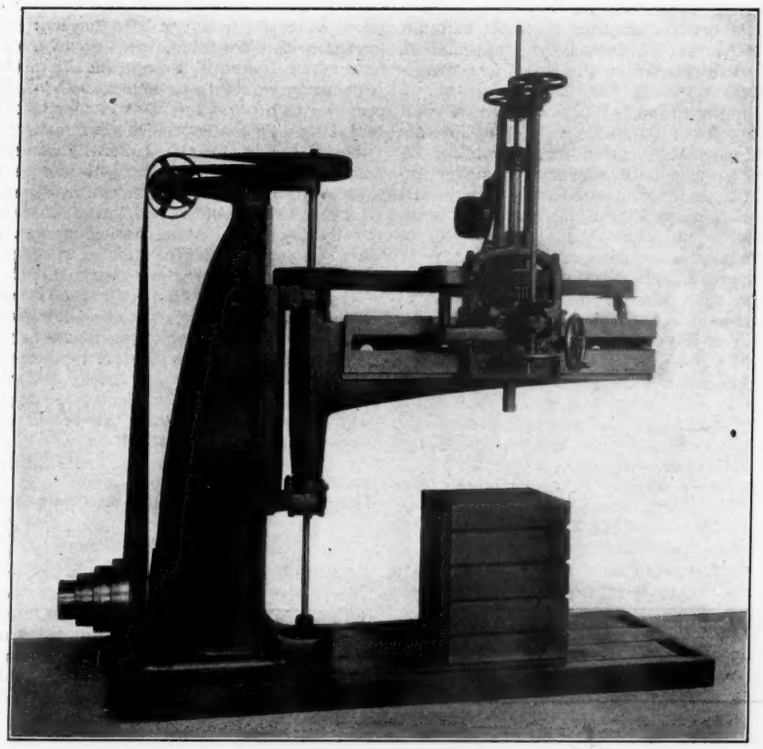


Fig. 3—The Sellers Radial Drill.

tion and well ribbed. Its weight is carried on ball thrust bearings which permits of its swinging freely when unclamped. The back gears and tapping device are located on the spindle head, and are arranged so that they can be engaged or disengaged without shock while the machine is running.

The positive geared feeds are eight in number and can be operated by hand or power. They are arranged in geometrical progression from .007 to .064 in. per revolution of the spindle. The spindle is counterbalanced and has 18 changes of speed ranging from 113 to 300 r.p.m. It is provided with automatic stop and quick advance and return. All operating levers are located on, and travel with the head, and are always directly in front of, and convenient to the operator. The lever for the tapping device starts, stops and reverses the spindle and when used in connection with the back gear lever, taps can be backed out at three times the tapping speed.

The speed box gives any one of six speeds, obtained by shifting the speed changing lever to positions as indicated on an engraved speed plate attached to the box. The drive is positive and is arranged so that the driving gearing is always started at a slow speed. The initial speed device overcomes the inertia of the gears and shaft and prevents any strain that might be caused by throwing in the regular shifting gears.

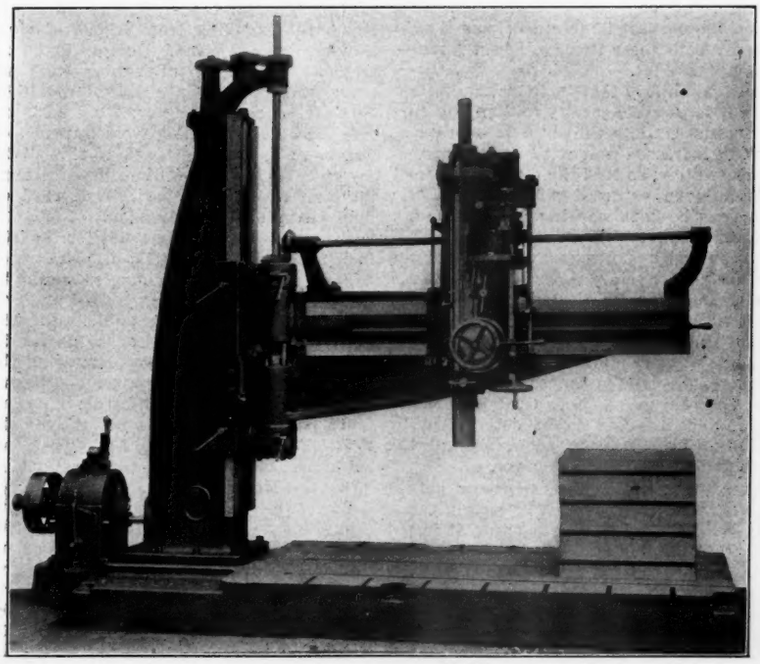


Fig. 4—The Fosdick Radial Drill.

The machine will drill to the center of 144 in. The traverse of the spindle is 20 in.; the minimum distance from the column to the spindle is 22 in.; the traverse of the saddle on the column is 50 in., and the traverse of the head on the arm is 54 in. The maximum and minimum distance of the spindle to the base plate is 72 in. and 22 in. respectively. The table is 24 in. x 27 in. and is 24 in. high. The total height of the machine is 11 ft. 1 in., and the highest position of the spindle is 11 ft. 11 in. The floor space required for the machine is 12 ft. 6 in. x 14 ft. 2 in., and the net weight is 14,115 lbs.

(To be continued.)

The Substitution of Electricity for Steam as a Motive Power.*

Ever since the first electric tram line was built in the Industrial Exhibition at Berlin in 1879, the possibility of using electricity as motive power on railroads has been discussed, and it may be claimed that for suburban traffic the superiority of electric motors over steam locomotives has been firmly established.

Such lines have been successfully in operation for some years near Milan and in other parts of Northern Italy, where the water-power of the Alps could be utilized, others have been started in Switzerland, Germany and France, while in the United Kingdom, the North Eastern Railway Company works its suburban lines near Newcastle by electricity, and the Lancashire & Yorkshire runs electric trains between Liverpool and Southport, and in London the conversion of the Metropolitan and Metropolitan District Railways is in active progress.

Naturally, the introduction of electric motors for working long-distance traffic has received considerable attention, and almost from the first the idea of accelerating the service was connected with that suggestion. A first attempt to solve the problem was made by M. Heilmann, who did not exactly substitute electricity for steam as a motive power, but placed a steam-driven generating plant on his locomotive to supply current to the electric motors which propelled the vehicle. Such locomotives were used for some time to work long-distance traffic; their use, however, has not been extended, although their introduction would not require any capital expenditure for altering the permanent way, or for the erection of central stations for generating electricity.

When secondary batteries were first introduced to public notice the promoters suggested constructing an electric locomotive which should carry its supply of electric energy in secondary batteries, but this idea was never carried out, as the weight of the cells required for a long journey is far too great, at least as long as the present form of accumulators has to be used. For the same reason it would be economically impossible to replace the propelling machinery of steamships by electric motors supplied with current from secondary batteries, in all cases where the batteries cannot be frequently recharged.

Judging by these failures, the way to introduce electric motors on main lines appears to be indicated by the success of tram lines and suburban railroads. In this direction experiments were carried out by Siemens & Halske, first at their own works and later on an experimental line near Gross Lichterfelde, but the shortness of the line

*Abstract of a paper by Alexander Siemens, M. Inst. C. E., presented before the International Engineering Congress, St. Louis, October, 1904.

prevented their making much progress, and they applied to the German Government for permission to equip a suitable length of the Government railroads.

During the negotiations with the Government a powerful syndicate was formed for carrying out the experiments on a suitable scale, and the results obtained on the experimental line between Marienfelde and Zossen have been officially stated by the syndicate in three yearly reports. The line is the property of the War Office, and was built for slow goods traffic. It is about 30 km. long, almost level and has no curves with a radius less than 2,000 m.

In 1901 the first set of experiments were carried out, which proved that the existing permanent way was unsuitable for any speeds exceeding 120 km. (75 miles) per hr. The next year was occupied by further preliminary investigations, and it was only in 1903, after the permanent way had been relaid in a manner equal to the construction adopted on the first class main lines of the German Government, that the real high-speed runs could be attempted.

For the purpose of these experiments two cars were built by v. d. Zuypen and Charlier, of Cologne, and their electrical equipment was supplied by the Allgemeine Elektricitäts-Gesellschaft and by Siemens & Halske, respectively, while the necessary current was supplied by the Berliner Elektricitäts Werke, at varying voltages, up to 14,000 volts. Each car carried transformers to reduce this voltage to the working pressure of its motors, and it was equipped with all the necessary apparatus for measuring and regulating all the various forces coming into play during the running.

In addition, Siemens & Halske supplied the electrical equipment of a locomotive, also built by v. d. Zuypen and Charlier, in which the high-tension current was supplied direct to the motors without the intervention of transformers.

The two cars, as well as the locomotive, were successfully tried at various speeds, either running alone or drawing a train, and a very complete series of observations were taken during each run, which were set out in detail in the official reports.

Owing to various circumstances the experiments will probably not be resumed this year, although the syndicate intend to resume them in the near future, but the conclusions arrived at up to the present may be summarized as follows:

1.—Permanent way, constructed in accordance with the standard specification for first class main lines of the German Government Railways, is sufficient for a line on which electric trains run at a speed of 200 km. (125 miles) per hr., but the radius of any curve should not be less than 2,000 m. (100 chains).

2.—The collector, devised by Siemens & Halske during their preliminary experiments, and modified according to the experience gained at Zossen, is well adapted for conveying the necessary electrical energy at high tension and at the highest speeds from the fixed conductors to the cars.

3.—The construction of the fixed conductor along the line as devised for Gross Lichterfelde, has proved its efficiency at Zossen.

4.—The successful running of the locomotive has demonstrated that high-tension currents can be used direct, without the intervention of transformers.

These results prove that technically it is possible to work trains by electricity on main lines, even at speeds greatly exceeding those of the present express trains. In their last report the syndicate publish two projects for such a line between Berlin and Hamburg, according to which such a railroad should also prove a success commercially. As already stated further trials are contemplated to determine the most suitable equipment for the cars and to experiment with modifications of the general arrangements.

While the problem has not yet been completely worked out, electric motors are accepted without question in the mining industry as decidedly superior to steam engines for underground work, and they will replace them also for working the main winding-drums, as soon as the qualities of electric motors are better appreciated.

Comparing generally the working of steam engines with electric motors connected to a permanent source of supply, the features in favor of the latter may be summarized as follows:

1.—The most suitable size of conductors to convey the current to an electric motor can be accurately determined beforehand, with the certainty that the loss of energy calculated upon will not be exceeded.

Such conductors are generally in the form of flexible leads, which are easily handled and readily adapted to their surroundings which they will not affect when properly selected and fitted, nor do they give rise to waste products that have to be separately disposed of.

2.—Owing to the simplicity of their construction and the absence of reciprocating parts, much less supervision is required for electric motors than for steam engines.

3.—For the same reasons the vibration caused by the working of electric motors is reduced to a minimum, and in consequence, heavy foundations can be dispensed with.

4.—This again makes it possible to shift motors readily from one position to another especially as the conductors in the shape of "wandering leads" are specially adapted for such purposes.

5.—Lastly, an electric motor connected to a permanent source of supply, is always ready to commence working, while a steam engine requires warming up, and very often, if the engine has a separate boiler, steam has to be raised specially, causing great delay in starting.

Against these advantages due account has to be taken: 1.—Of the losses, caused by the double transformation of energy; and 2.—Of the interest on the additional capital expenditure.

When the current is obtained from a public supply both these items are partly represented by its price.

It will be noticed that by utilizing electric motors it is possible greatly to diminish current expenses, while the interest on capital outlay is increased and with it the charges for depreciation, so that the most economical result may be expected when the electric motors can be kept working for long hours. In other words a high load factor is as advantageous with motors as with generators to obtain a satisfactory return for the change from steam power to electric motors. This makes it possible in many cases to decide without difficulty whether it is advisable to substitute electric motors for steam engines, but there are also instances where electric motors are cheaper although the load factor is low, and this has to be determined by carefully considering in each case all the possibilities for providing power.

Generally speaking, the experience gained hitherto makes it clear that in certain cases, notably for the propelling of ships, it is not likely that electric motors will ever replace steam engines, on the other hand it appears certain that the days of small, scattered, steam engines are over, whether they have separate boilers, or are fed by long steam pipes from a nest of boilers.

Electric motors have not only replaced steam engines, but they have been adopted for a great many purposes where steam engines have either never been used or have proved to be unsuitable; these cases are not, however, germane to the subject set for this paper, nor would it be appropriate on this occasion to discuss the relative merits of alternating and continuous-current motors beyond referring to the generally accepted opinion, that continuous-current motors are most suitable in cases where the speed of running has to be varied often and to a great extent, while alternating-current motors are most efficient in cases where long runs at constant speed are required.

The conclusion to be drawn from the consideration of the relative position which steam engines and electric motors occupy at present, appears to be that it is more correct to regard the one as the supplement of the other rather than to expect a complete substitution of electricity for steam as a motive power.

The St. Louis, Memphis & Southeastern Railroad.

On June 1st last, the completion of a line from Southeastern Junction, near St. Louis, to Cape Girardeau, Mo., 124 miles, opened to through traffic a new single track road of favorable grades between St. Louis and Memphis. The line thus opened forms a part of the St. Louis, Memphis & Southeastern Railroad, which operates 458 miles of main track, running for the most part adjacent to the Mississippi River and which is a part of the Frisco system.

The heavy full lines on the map indicate properties of the St. Louis, Memphis & Southeastern and the heavy broken lines indicate the lines of the St. Louis & Gulf, the entire network now being known as the Third District of the St. Louis & San Francisco. A few miles south of Cape Girardeau, Mo., the line divides into two main branches; one, the Memphis division, continuing due south to a connection with the St. Louis & San Francisco at Big Creek, Ark., and the other, the Hoxie division, running southwesterly, connecting with the "Frisco" at Hoxie, Ark.

In building the Memphis division, the St. Louis, Memphis & Southeastern acquired for $648,000 on March 1, 1902, the St. Louis & Memphis, extending from Lilbourn, Mo., to Luxora, Ark., 72 miles. During the summer and fall of 1902, 47 miles were built north from Lilbourn to a connection with the Hoxie division at Shepley, Mo. On June 1, 1904, 34 miles extending from Luxora to Big Creek, Ark., were assigned to this division for operating purposes, thus constituting 153 miles of continuous single track road operated as the Memphis division.

In completing the Hoxie division the following lines were acquired: First, Cape Girardeau & State Line, 46.7 miles long, extending from Cape Girardeau to Mingo; second, the Southern Missouri & Arkansas, 35.4 miles long, from Mingo south to the Arkansas State line; third, the Hoxie, Pocahontas & Northern, 45.8 miles long, from the southern terminus of the Southern Missouri & Arkansas south to a connection with the St. Louis & San Francisco at Hoxie, Ark. These roads, with the Hunter branch, 46 miles long, comprise the Hoxie division.

To utilize these lines as through connections and to compete with river traffic between St. Louis and Memphis it was necessary to build a road with favorable grades from St. Louis to Cape Girardeau. Early in 1903, the St. Louis, Iron Mountain & Southern opened for traffic the St. Louis Valley, a competing line, along the east bank of the Mississippi River from East St. Louis to Thebes, Ill. This made the situation more

urgent and hastened the completion of the St. Louis line.

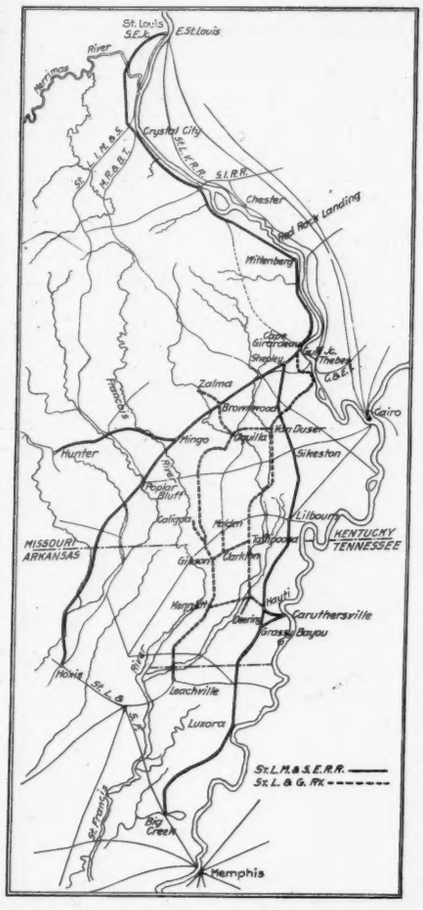
From Southeastern Junction to Cape Girardeau is 124.1 miles, and for this entire distance the new line follows the river closely. The alinement is therefore quite irregular, there being 317 curves, with an aggregate length of curved line of 35.2 miles. There are 58 ascending grades, the sum of the ascents being 7,089 ft. and the aggregate length of ascending grades 36.3 miles; 65 descending grades, with a sum of descents of 8,223 ft. and an aggregate length of descending grades of 58.5 miles. The length of level line is 29.3 miles. The section built in 1902 from Shepley to Lilbourn, 47.2 miles, has 24 ascending and 37 descending grades, but these are much lighter than on the river divisions, the sum of the ascents being 813 ft. and of the descents 1,300 ft. There are only 11 curves. Expressed in percentages, 78 per cent. of the total length of 171 miles is tangent and 22 per cent. is curved. The length of the longest tangent is 6.9 miles, the longest curve 0.6 mile and the sharpest curve is 5 deg. The ruling gradient between Southeastern Junction and Crystal City, a distance of 33 miles, is 52 ft. per mile, compensated. From Crystal City south to Big Creek, Ark., 242 miles, there are no grades in either direction heavier than 15 ft. to the mile.

The width of roadbed in excavation was generally 24 ft. with 1 to 1 slopes in earth. On embankments the width was generally 18 ft. with side slopes 1½ to 1. For the first 28 miles north of Cape Girardeau, the earthwork quantities averaged about 17,000 cu. yds. per mile. Where the line followed close to the river, considerable rock was blasted from side hill cuts and was used as riprap. From Wittenburg to Red Rock Landing, 14 miles, the earthwork was light and was borrowed principally from the sides. From Red Rock Landing to Crystal City, 50 miles, the construction involved no especially heavy work or unusual features.

From Crystal City north to the Merrimac river, 22.5 miles, the earthwork quantities averaged 37,000 cu. yds. excavation and 46,000 cu. yds. embankment per mile. The profile shown is from this section of the line. One cutting, 4½ miles south of the Merrimac river, was one-half mile long, 60 ft. high and contained 116,000 cu. yds. of material, of which 70 per cent. was solid rock, 15 per cent. loose rock and 15 per cent. earth. This cut was opened in April, 1903, and completed in April, 1904. From the Merrimac river north to Southeastern Junction the quantities averaged 36,000 cu. yds. excavation and 39,000 cu. yds. embankment per mile.

The grading contract from Southeastern Junction to Crystal City, 33 miles, was let to McArthur Brothers Company, Chicago, and from Crystal City to Lilbourn, 91.5 miles, to Johnston Brothers, St. Elmo, Ill. The movement of material under these contracts began in January, 1903, and the grading was practically completed in April, 1904. During the latter part of April of the present year considerable work was damaged by high water from the Mississippi River and tributary streams.

The smaller waterways were provided with stone box culverts or iron pipe varying from 12 in. to 30 in. in diameter. Between Southeastern Junction and Cape Girardeau there are 164 timber bridges aggregating 20,200 ft. in length, also a number of permanent structures as follows: Fourteen plate-girder spans aggregating 870 ft. in length and 11 through pin-connected spans of a total length of 1,350 ft. The most important bridge, that across the Merrimac river, consists of three pin-connected through spans, each 150 ft. long. These spans are supported by four piers containing some 3,300 cu. yds. of concrete. All bridges were designed for Cooper's E-40 loading. Difficulty was encountered in the erection of this and other structures by reason of spring freshets carrying away the falsework.

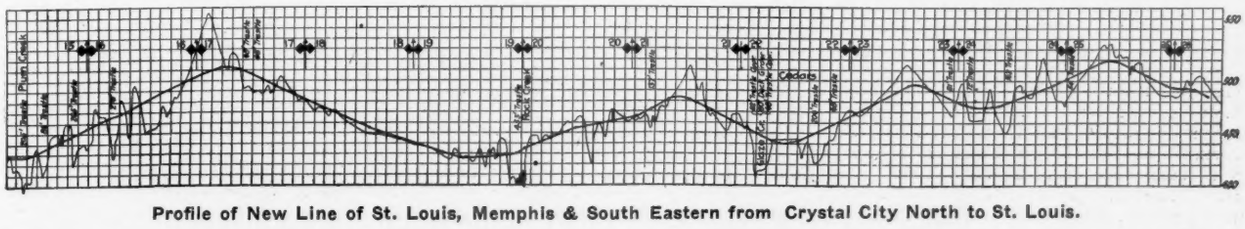


Map of St. Louis, Memphis & South Eastern.

From Southeastern Junction to Big Creek, Ark., 275.8 miles, the line is laid with 75-lb. rails on white oak ties averaging 3,100 per mile. Eighty-three miles are ballasted with crushed limestone, 51 miles with chats and the remainder principally with sand. Tracklaying was started at Cape Girardeau on January 16, 1903, and proceeded northward at the rate of about 1,800 ft. a day. The track reached Red Rock Landing, 41 miles north, on August 16, 1903. Crystal City, 91 miles north, was reached about Feb. 8, 1904.

Early in 1903, a Holman track-laying machine and the force to man it were shipped across the river and began laying track south from Southeastern Junction. On Feb. 11, 1904, the track reached the rock cut, 16 miles south, where work was stopped. The force then resumed laying north from Crystal City about the middle of February, 1904, and a connection was made with track from the north on March 17. The rate of progress on this section was about 3,800 ft. a day.

We are indebted to W. S. Dawley, Engineer Maintenance of Way, and to R. Y. Maxon, Assistant Engineer, for the foregoing information.



Profile of New Line of St. Louis, Memphis & South Eastern from Crystal City North to St. Louis.

Small Curtis Turbines.*

The problems of design which have to be solved in the small steam turbine units are of a somewhat different character from those involved in the larger sizes. In order to keep the dimensions and cost of apparatus at a proportionate figure, the diameter of bucket wheels must be kept small, and this necessitates a comparatively high speed. These speeds must be chosen with reference to the possibilities of generator design in order that the units may be direct-connected. Therefore a proper balance must be struck between the requirements of the turbine and those of the generator. The speed necessary in the small units (from 1,800 to 5,000 r.p.m.) gives rise to a set of conditions not met with in large units and certain differences in design have arisen from this fact.

Some of the special problems which require solution on these small sizes are balance, construction and lubrication of bearings, flexible couplings between turbine and generator for sizes of 75 k.w. and above, and the commutator construction on direct-current apparatus. It is possible to balance the turbine parts statically with success, to operate at the speeds given, since the wheels may be balanced individually and collectively and the metal of each wheel is disposed in the form of a flat plate. With the generator, however, this condition is not present, and furthermore we have the liability of the generator or winding undergoing some change after being put into service, due to heating and other causes. For this reason it is necessary to balance the generator parts by rotating them in a vertical position and suspended by a flexible shaft. The rotating parts in this system of balancing take up rotation about the center of gyration of the system and by the addition of balancing weights at various points this center is made coincident with the center of rotation of the shaft. Due to the symmetrical shape of the Curtis buckets a very small amount of end thrust has to be taken care of; whatever thrust exists being due to accidental variations in bucket or nozzle shapes and this is easily taken up by hardened steel thrust washers placed on each end of one of the bearings. No balancing pistons are necessary.

The question of bearings is of course a

*Extracts from a paper presented to the St. Louis Convention of the American Street Railway Association by Richard H. Rice.

very important one and has been made the subject of a great deal of investigation. The bearings now in use are supported on spheres, so that they are self-alining. The linings are made in two parts and lubrication is effected by forced feed from a pump which is geared to the main shaft of the turbine and supplies oil at a pressure of from 3 to 6 lbs. per sq. in. The circulation of the oil is constant, passing from the pump to the bearing, thence to a reservoir in the pump chamber, from which it again goes to the pump. It has not been found necessary to provide any cooling arrangement for the oil and a very small amount of make-up oil is necessary.

A number of small sets are being used for train lighting service. Some are placed on the buffer beam, or just in front of the steam-dome of the locomotive, and others in the baggage car. The conditions of service are widely different on the locomotive and in the baggage car. In the former case the turbine is supplied with steam at 175 to 200 lbs. pressure and exposed to great variations of temperature. Some trouble was experienced last winter with the sets mounted on the buffer beams, due to congealing of the oil circulation, but this was overcome by the use of a special oil. It is not expected that this trouble will be met with in the sets which are mounted on top of the boiler. Dust and cinders are very troublesome on the locomotive and the machine is enclosed as much as possible, to prevent their access to the vital parts. It is, however, necessary to take in a large quantity of air for the purpose of cooling the generator and this air necessarily carries with it a certain proportion of fine dust, which, however, does not prevent satisfactory operation. In the baggage car the turbine is normally supplied with steam at 80 lbs. pressure, but for various reasons the pressure actually realized varies from this figure down to 40 lbs.

The 1½, 15 and 25-k.w. turbines are governed by throttle valves, these being of the piston type, moved directly by a very sensitive and powerful centrifugal governor with spring. The nozzles are therefore supplied with steam at pressures varying with the load. The governor joints are supplied with knife edges and do not require lubrication. All of these machines are of the single-stage type, having a single group of nozzles with single sets of buckets, consisting of three rows of moving buckets with corresponding rows of stationary buckets. The larger sizes are multi-stage and have only two rows of moving buckets per stage. The method of governor control on these larger sizes is somewhat different from that just described. One or more nozzle groups are supplied with steam from a single poppet valve and a sufficient number of poppet valves is supplied to furnish the total number of nozzles necessary for developing the capacity of the turbine. Each poppet valve is therefore the means of controlling the admission of steam to one or more nozzles and the governor, by means of an intermediate mechanism, opens or closes a succession of poppet valves as the demands of the load require.

Two types of intermediate mechanism for operating these poppet valves have been developed and constructed. The 75-k.w. turbine is supplied with one of these types, consisting of a hydraulic cylinder the controlling valve of which is directly actuated by the governor. A movement of the controlling valve, caused by a change in the speed, admits oil to one side or the other of the piston of this cylinder and a movement of the cylinder results, through the intermediate mechanism, in the opening or closing of corresponding poppet valves. The 150-k.w. turbine is supplied with a mechanical valve gear, the valves being actuated by gearing which derives its motion from the main shaft. The governor control operates a mechanical device which produces the same effect on the poppet valves as that above described.

The operation of direct-current commutators at the speeds in question has necessitated the development of various special features in the commutator. Carbon brushes are used throughout, the best form of brush being one which has been treated with a lubricant, and with this form of brush, commutation is very satisfactory. On account of the high speed and great length of the commutator bars they are provided with nickel-steel shrink rings at the ends and middle of their lengths to prevent deflection. These rings are shrunk on over insulation and provide a very effective means of supporting the commutator bars and also have the advantage of giving a greater wearing depth of copper than the usual construction. The steam consumption curves of these small turbines differ somewhat in characteristics from those of large turbines of the same type, in having a comparatively high steam consumption at light loads. This is because the fixed losses, such as bearing friction and windage of the wheels are a greater proportion of the total output.

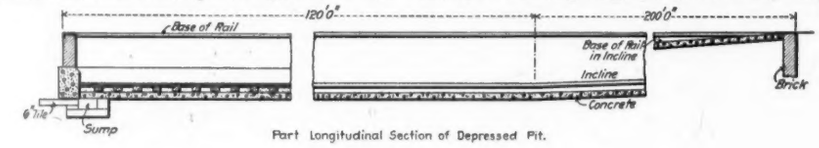
All of these turbines are of the horizontal type, the vertical type commencing with the 500-k.w. and proceeding upward. The three smaller sizes have two bearings. The turbine wheels are overhung on the end of the shaft and the shaft is in one piece, with the turbine and armature both mounted on it. Beginning with the 75-k.w. size and upward the shafts are in two pieces and the sets have four bearings.

In the four-bearing sets the generator and turbine shafts are united by a flexible coupling which permits some little inaccuracy in the alinement of the two shafts without affecting the operation of the set. After extended experience with various forms of these couplings a construction involving the use of metal parts only has been found to be the most satisfactory. This coupling is a modification of the Oldham coupling, the necessary flexibility being secured by the use of links turning on pins.

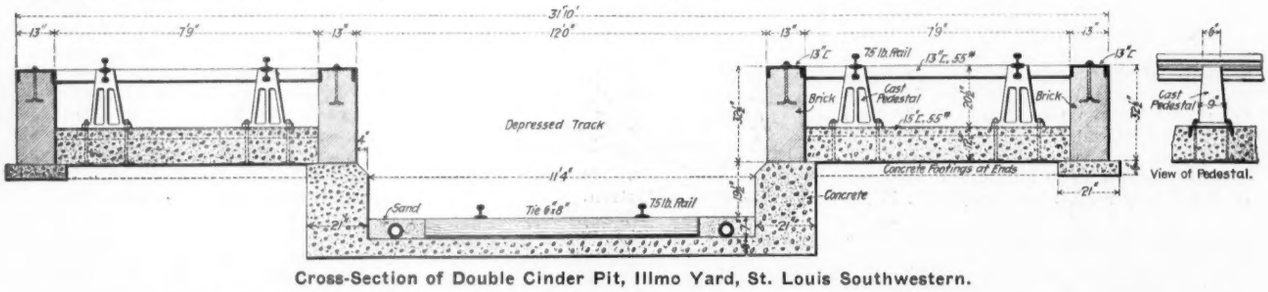
Some progress has been made in the application of turbines to driving other forms of apparatus than electric generators. Some small turbines are in operation with a belt drive with a fair amount of satisfaction. Other forms of gearing are under construction and experiment, and it is safe to predict that it will soon be possible to couple the smaller sizes, at least, of these turbines to slow-moving apparatus with satisfaction.

The Illmo Yards of the St. Louis Southwestern.

The St. Louis Southwestern, which is one of the roads interested in the Southern Illinois & Missouri Bridge Company, owner of the Thebes bridge across the Mississippi River, is building large yards at Illmo, Mo., for use in connection with the bridge. The yards are located about two miles west of the Missouri end of the bridge and are entirely new. They lie on level ground, at the foot of a range of low hills running east and west. Protection against the drainage from these hills is provided by a large intercepting ditch along the north side of the yards, which discharges through a covered culvert under the tracks at the west end of the yard. There will be 31 yard tracks with yard room for about 2,000 cars. The facilities will include a brick roundhouse on concrete foundations, with a stall depth of 80 ft., and served by a 70-ft. turntable. It is planned for a full circle, but only 19 stalls will be built at present. Two stalls of the house will be partitioned off and equipped as a machine shop. Provision will also be made for car repairing on stub tracks west of the roundhouse. Small store and oil houses will be built, and a steel stand-pipe 20 ft. in diameter and 100 ft. high. There will be a 24-pocket coal chute, and between the latter and the roundhouse a double cinder pit which is a special design will be built. The accompanying drawings show the details of this pit.



Longitudinal Sections of Double Cinder Pit.



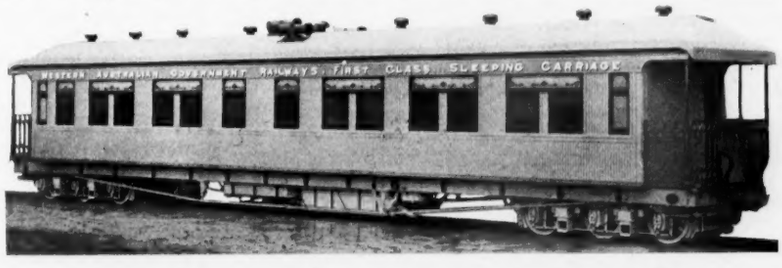
Cross-Section of Double Cinder Pit, Illmo Yard, St. Louis Southwestern.

There are two pits 120 ft. long, on opposite sides of a depressed track. The pit for the latter has a bottom lining of concrete 6 in. deep, above which is a filling of sand in which the ties are bedded. The walls of this pit are concrete 21 in. thick for a height of 32½ in., which is the level of the tops of the concrete footings for the brick side walls of the cinder pits. These latter are 32½ in. high and are protected on top by 13-in. 55-lb. channels held in place by 14-in. anchor bolts bedded in the brick work. The cinder pit tracks are carried on cast-iron pedestals 7 ft. 6 in. on centers. The pedestals rest on 15-in. 55-lb. channels laid transversely and bedded in concrete, a 12-in. layer of which lines the pit bottom. The pedestal anchor-bolts extend through this concrete. The track rails, which weigh 75 lbs. to the yard, are laid on inverted rails of the same weight which fit into recesses in the pedestal tops conforming to their outline. The flanges of the upper and lower rails are riveted together.

The Southern Illinois & Missouri Bridge Company is building a similar yard parallel to and immediately south of the St. Louis Southwestern's yard. The drawing of the cinder pit was sent us by Mr. M. L. Lynch, Chief Engineer of the St. Louis Southwestern.

Sleeping Cars for the Western Australian Government Railroads.

The Western Australian Government Railroads have recently placed extensive orders for locomotives and rolling stock in the United States and in England. The American Car & Foundry Company furnished 50 steel hopper coal cars and a large number of 16-ton gondolas, and the Gloucester Railway Carriage & Wagon Company, of Gloucester, England, obtained a large order for new passenger equipment, including a number of



First Class Sleeping Car, Western Australian Government Railways.

first class sleeping cars and second class corridor cars. The accompanying illustration shows one of the first class sleeping cars made by this company. It is 58 ft. long over the end platforms, 8 ft. 9¾ in. wide at eaves. and weighs 32 tons. The standard gage in Australia is 3 ft. 6 in., and the six-wheeled trucks on which these cars are mounted are built for that gage. The sleeping cars are divided into six compartments, four of which can be made up into four berths and the other two, which are in the center of the car, can be made up with a single upper and lower berth. For day travel the four-berth compartments will seat six passengers each, and the two-berth compartments will seat three passengers each. A narrow corridor runs along one side of the car and the compartments are entered through doors leading off from this corridor. The two single compartments in the middle of the car are connected by a door through the partition, so that they may be used in common if desired. The seats are transverse, as in Pullman sleeping cars, but each seat is long enough and wide enough so that transverse berths can be formed by lifting the seat backs and slinging them from the roof. There are lavatories at each end of the car having a water supply from tanks built in the roof, with a reserve supply carried in two tanks hung underneath the floor. The cars have open end platforms, as will be seen from the illustration, and are fitted with automatic vacuum brakes applied to four of the six wheels on each truck. The body framing of the car is teak wood and the underframe is made up of steel channel sills and pressed steel cross members.

The interior decoration of the car is very ornate. All the panels and mouldings are of polished teak, decorated with hand carved work, and the seats are upholstered with dark maroon-colored leather. An interesting feature of these cars is the very complete system of ventilation which has been designed. The roofs are double, with air intake and exhaust ducts running in between the layers. These ducts are connected with intake and exhaust ventilator hoods extending up through the roof, and they are also carried down inside the car frame and open into each compartment. By this means each compartment is constantly supplied with a current of fresh air, which is kept in constant circulation. The cars are lighted throughout with electricity.

The International Engineering Congress.

The International Engineering Congress held under the auspices of the American Society of Civil Engineers at the World's Fair, St. Louis, met for the first time on the morning of October 3 in Congress Hall in the Administration Building. Col. Henry S. Haines, chairman of the committee in charge, presided at the general meeting, and in addressing the Congress reviewed briefly the history of its inception and organization. The managers of the Louisiana Purchase Exposition requested the American Society of Civil Engineers to undertake the arrangements for the meetings and the invitation was accepted. The other three national engineering societies declined the invitation extended to them by the committee appointed by the Civil Engineers to participate as organizations in the work of the Congress and so the Civil Engineers undertook the work alone. The committee in charge determined to confine the discussions at the meetings to a few live topics rather than to attempt to cover the whole field of engineering and having selected these subjects, invited papers on them from leading engineers from all over the world. North and South America, Europe, Africa and Asia all responded so that the Congress was indeed an international one.

Mr. Charles Hermany, President of the American Society of Civil Engineers, and President of the Congress, was then introduced and delivered an address of welcome. He expressed the hope that the work of the Congress would result in great benefit to those in attendance and that the papers and discussions would stand as a review of the engineering accomplishments of the last ten years. Enthusiasm and extraordinary effort, he said, overcame the apparently insurmountable obstacles where earnestness of purpose and industry failed before, and more than any other body of men, engineers must have these qualifications to be really great.

After the address of welcome had been responded to by Mr. F. B. V. Skiff, Director of Exhibits at the Exposition in the absence of President Francis, Mr. Hermany introduced Sir William White, K.C.B., F.R.S., President of the Institution of Civil Engineers of Great Britain, who headed a delegation of that body at the Congress. He spoke at some length in a charming and appreciative manner. For the first time in the 86 years of its existence, the Institution was holding a meeting outside of England as a part of this Congress. On behalf of the Institution and all the visiting delegations of engineers he thanked the American Society for its reception in this country and for the work which it had done in organizing and carrying out the work of the Congress. He referred to the work of the Institution of Civil Engineers in the matter of standardization in engineering work, and called attention to the value of concerted action in that direction not only to engineers but to manufacturers as well. The Institution has also taken up another broad phase of its work, engineering education, and a committee is already formulating recommendations which will tend to raise the profession of engineering to the high plane which is properly its own. St. Louis had a monument to one of the greatest of their profession in the Eads bridge across the Mississippi river. Capt. Eads' name was cherished in England as well as in America as a man knew not what it was to fail in carrying out the stupendous works with which he was identified.

Speaking of the work of the Congress, he mentioned the educational effect of holding it at such a place as this Exposition when the members were surrounded by examples of the skill and scientific achievement of their fellow-workers. Science and engineering went hand in hand and the engineer must be a man of science to deal with the great problems confronting him. But while the trend of engineering was specialization, the branches of that profession must ever overlap and be dependent on one another. Thus while this Congress was considering many subjects apparently widely separated, yet each was related to the other, and all of those who participated in the discussions would be bound by the common tie of engineering. As an example of this he spoke of the modern ship in the construction of which all of the branches of engineering take an essential part and yet the naval architect takes the immediate responsibility and only avails himself of the skill of his associates.

As director of naval construction Sir William White had directed the expenditure of more than 500 million dollars on ships and armament, and yet he held that this had made for peace rather than for war. The engineer had made possible the modern war-ship and hence he was responsible in a way for the world's peace. The execution of a war demanded the highest skill of the engineer in many if not all of the branches of the service. His text, if it might be so-called, was that engineers the world over were an army fighting the adverse forces of nature for the benefit of mankind.

Representatives from France, Germany, Argentine Republic, Russia and Austria then spoke briefly, and some further routine business was disposed of before the meeting adjourned.

At a session held Monday afternoon, the American Society of Civil Engineers held its

annual meeting. President Hermany read his annual address and routine business was disposed of. The selection of a place of meeting was referred to a special committee, although Secretary Hunt said the result of a recent letter ballot showed a strong preference among the members for holding the next meeting at Cleveland, Ohio.

On Tuesday morning each section held an independent meeting for the discussion of the subjects assigned. Only abstracts of the discussions of a few of the sections can be reprinted here.

SECTION F—ELECTRICAL.

The Substitution of Electricity for Steam as a Motive Power.

This section was presided over by Mr. George H. Pegram in the absence of Mr. Frank J. Sprague. The paper by Mr. J. G. White, M. Am. Soc. C. E., was read and the discussion was opened by Mr. L. B. Stillwell, of New York. He thought that the application of electricity should not even be considered for steam roads on which the present traffic is not more than 10,000 ton-miles per mile of double track. The saving in cost of transportation by electricity over steam with a traffic density as low as this is more than offset by the charges on increased capitalization. One great advantage of electric traction about which little has been said is the fact that with motors properly distributed through the train, grades of 6 per cent. and even as high as 10 per cent. are not prohibitive, the objection to such grades being the difficulty of holding trains when descending them. With electric traction it is possible to utilize the magnetic track shoe brake as well as shoes on the wheels so that this objection might well be overcome. The ruling grade on any line should of course take into consideration power requirements as offset by first cost of line construction. The Wilkesbarre & Hazelton uses a 3 per cent. grade and competes with the steam roads which it parallels, in places on which the grades are less than 2 per cent. The electric road has a route only 30 miles long compared with 50 miles for the steam roads, chiefly because the heavier grade could be used; and a speed of 30 miles an hour is maintained going up this grade with a trailer car attached.

Referring to the third rail and its protection from sleet and snow as well as from accidental contact with employees or trespassers Mr. Stillwell suggested the use of a plank covering above the rail supported from brackets attached to the rail itself. This has been successfully tried in severe storms and while not altogether satisfactory is still much better than an unprotected rail. It requires a special form of collector shoe pivoted to the truck.

Roads operated by electricity have lighter charges for maintenance-of-way because of the better distribution of weight under motor cars and the entire absence of the effects of unbalanced reciprocating parts. Track construction for electric roads cannot be made too substantial even though the expense of its maintenance is much less than for similar construction on steam roads.

The saving in coal with a central station electric power plant over steam locomotives is greater than is often assumed. The plant of the Manhattan Elevated delivers power to the switchboard at the rate of 2.6 lbs. of coal per kilowatt hour under conditions of full load, and the power is delivered to the motors through the third rail with about 60 per cent. efficiency, giving a consumption of 4.3 lbs. per kilowatt or 3 lbs. per horse-power at the drawbar. A road with heavy traffic and a large and efficient central power station should use only about half as much coal as when using steam locomotives, and this may even be reduced under favorable conditions to one-third.

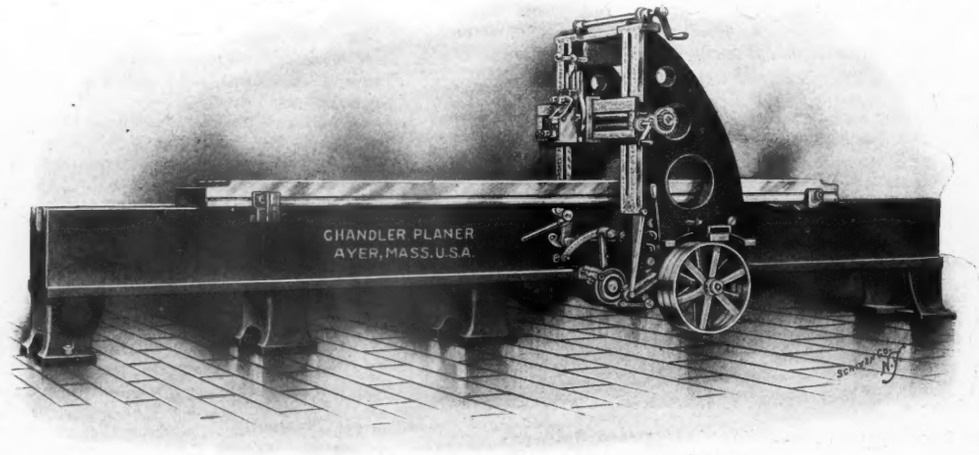
The repairs to electric machinery ought not to exceed 2½ per cent. per annum on the first cost, and if in addition a sinking fund of 5 per cent. is provided for, the total charge for maintenance and renewals is only 7½ per cent. as against about 20 per cent. for repairs alone in the case of steam locomotives.

In discussing the paper presented by Mr. Alexander Siemens, Mr. Stillwell pointed out that the single-phase alternating current motor requires more weight on the drivers for a given drawbar pull than the three-phase motor, since the torque of the former varies with the alternations, and theoretically the average torque is one-half the maximum. Investigations made at Buda Pesth showed the ratio of adhesive weights required for single-phase and three-phase motors was actually about 3 to 1 instead of 2 to 1, since the three-phase motor has a nearly constant torque and the single-phase motor exerts only a small effective drawbar pull in proportion to the weight on drivers. The electric motor has an advantage of 15 to 20 per cent. in this respect over a steam locomotive because of the unequal rotative effort on the two cranks. The mechanical efficiency of the average steam locomotive derived from the power developed in the cylinders and the power delivered at the drawbar has been found by road tests to be less than 50 per cent., but with electric motors no such loss as this occurs.

The discussions of papers of other sections will be printed in abstract in a subsequent issue.

The Chandler Quick Return Planer.

The accompanying illustration shows a planer made by Chandler Company, Ayer, Mass., and designed for the use of high-speed tool steel. The main feature of this machine is the high cutting and quick return speeds which can be obtained. Any cutting speed up to 100 ft. per min. is guaranteed. If the cutting speed does not exceed 75 ft. per min., the platen is returned at a speed of 200 ft. per min., and if the cutting speed exceeds 75 ft. per min. the platen is returned at 150 ft. per min. It is claimed that at these high speeds the platen reverses smoothly and without shock or jar. A novel method of changing the speed of the platen without changing the speed of the driving belts is used. This variable speed mechanism is in the train of gears, between the pulley shaft and the bull gear. It is operated by a lever and serves the same purpose as back gears of a lathe; that is, the pressure at the tool point is inversely proportional to the platen speed. Three belts are used on the planer, one for driving when cutting, one for reversing, and one for running the platen back at high speed. As the platen approaches the end of the cutting stroke, the tappet encounters an incline on the dog and is lifted to a position which throws off the cutting belt and throws on the reversing belt, running at a speed that will most effectively reverse the cutting movement of the platen. The two belts are shifted practically as they are in planers of other makes.



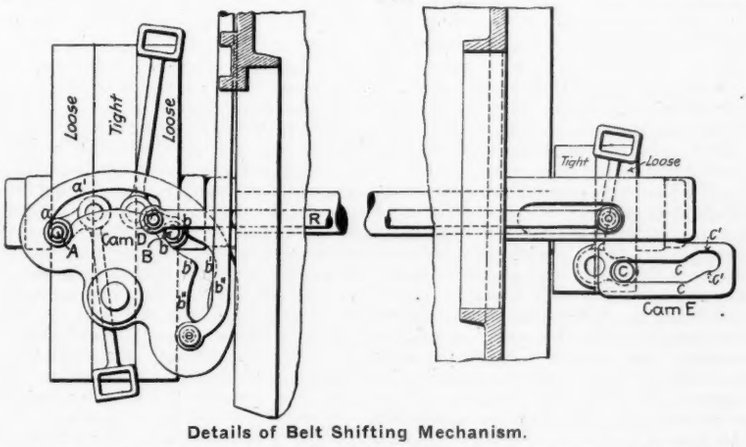
The Chandler Planer.

As soon as the platen starts back on its return stroke, however, the tappet encounters a second incline on the dog and is further elevated, throwing off the reversing belt and throwing on the high-speed return belt, which remains in action until near the end of the return stroke, when the tappet encounters a two-step dog, which, on the first step, throws off the high-speed return belt and throws on the slow return or reversing belt. The second step of the dog then throws off the reversing belt and throws on the cutting-speed belt.

The cutting-speed and reverse belts are on the front side of the planer, as in the ordinary type, and the high-speed return belt is on the opposite or rear side of the machine. The arrangement of the belts, pulleys and cams is shown in the accompanying illustration. At the left are two loose pulleys and one tight pulley and on the same shaft at the right are the tight and loose pulleys for the high-speed belt. The two belt shifters at the left are controlled by an oscillating

cam having two slots for the rolls, *A*, *B*, attached to the short arms of the shifters. This cam is connected with the sliding cam at the right by the rod *R* so that the two move in unison.

Starting with cam *D*, and with the cutting-speed belt on the tight pulley, as shown, a movement of the cam to the left causes roll *A* to ride up on surface *a*, *a'*, shifting belt to loose pulley, where it remains until the cam again returns to this point. In the meantime roll *B* travels on surface, *b*, *b'*, causing the reversing belt to shift to the tight pulley, where it remains momentarily, and then shifts back to the loose pulley again as the roll passes over the cam surface from *b'* to *b''*. While this belt is being shifted back to the loose pulley, the curved part of cam *E* comes into action and shifts the high-speed belt onto its tight pulley, the roll *C* being in contact with cam surface *c*, *c'* during this motion. When the platen finally reaches the other end of its stroke these successive motions occur in the reverse order and the platen is finally carried back to its original position by the slower cutting-speed belt. When the quick return speed is not desired, such as when doing short stroke work, etc., the high speed belt can be thrown out of operation by lifting a latch on the return dog, and the platen is returned on the intermediate speed or reversing belt. The feed regulating mechanism is operated by a lever moving on a marked dial and is always under the immediate control of the operator. The shafts and bearings in this planer are of liberal proportions and are case hardened and ground.



Details of Belt Shifting Mechanism.

It is claimed that with a cutting speed of 50 ft. per minute, this planer removed from machinery steel, with a 2 in. belt transmitting 6½ h.p., a chip ¼ in. deep x ⅛ in. feed. Allowing that 6 h.p. out of the total of 6½ h.p. are required in the act of cutting, and conceding but one-half horse-power is required for operating the planer, these figures would indicate the removal of 54 lbs. of steel per horse-power per hour. From cast-iron, at a cutting speed of 50 ft. the Chandler planer removed a chip ⅝ in. deep by $^1/_{16}$ in. feed. The belt in this case was transmitting 6½ h.p., which on the above basis is equivalent to removing 68 lbs. per h.p. per hour. At a cutting speed of 50 ft. per minute and a return speed of 200 ft. per minute, the Chandler planer on a 13-ft. stroke, makes a round trip in 20 seconds. At the request of a large ship-building company who desire to use a high-speed planer on brass work, a Chandler planer is being run at a cutting-speed of 92 ft. and a return speed of 150 ft., on a stroke of 6 ft., making the round trip in 7½ seconds.

The production of anthracite coal of the first nine months of this year decreased 4,922,525 tons over last year.

Twenty-Seven Passengers Killed at Warrensburg, Mo.

On the morning of October 10, before daylight, a butting collision between an eastbound passenger train and a westbound freight on the Missouri Pacific, about two miles east of Warrensburg, Mo., resulted in the wrecking of both engines and many cars and the complete destruction of the leading coach of the passenger train. Twenty-seven passengers and one brakeman were killed and about 30 passengers and five trainmen were injured, some of them fatally. Both trains were running at high speed, the point of collision being near a hollow between two summits. It is said that the engineman of the freight forgot a meeting order.

Six Men Suffocated in St. Clair Tunnel.

On the morning of October 9, five trainmen of the Grand Trunk Railway and the company's Superintendent of Terminals at Port Huron were killed in the tunnel under St. Clair river between Port Huron, Mich., and Sarnia, Ont., a freight train having broken in two, causing a long delay in the tunnel. The train, which entered from the American end of the tunnel and was made up of 17 cars of coal, broke in two. Engineer Coleman, with the three cars that were still attached to the engine, ran to Sarnia, detached his engine and went back for the stalled cars. He attempted to push them back through the tunnel and out of the American portal, but could not get up the grade, and the engine and cars rolled back into the gas-laden tunnel. Coleman was suffocated at his post in the cab. His fireman, Fred Forester, with great presence of mind, jumped into the partly filled tank of the engine, where there was enough air to preserve his life, although he was taken out in a serious condition.

When news of the broken train reached the American side of the tunnel, Mr. Begg, Superintendent of Terminals, accompanied by two other employees, started in on foot, but they had gone but a short distance when the coal gas became stifling, and Begg succumbed. The other two rescuers succeeded in crawling to the portal.

Meanwhile preparations were being made at the Sarnia end of the tunnel to rescue the imprisoned crew. An engine with a party of rescuers entered the tube and had proceeded but a short distance when they found John Haley, a track walker, lying unconscious on the track. He was taken out and again the engine plunged into the tunnel. The rescuers were overcome, however by the gas before the train was reached, and Brakeman McGrath died. Switchman Blake, who was a member of the party, after a time made another attempt, and succeeding in reaching the stalled engine, coupled it to the cars and ran the train out into the daylight. Conductors Simpson and Tinsley, and Brakeman Gillis were found dead in the caboose. Fireman Forester was in the tank of the engine nearly two hours before he was rescued.

Structural Steel Fractures Under Alternating Stresses.

At the meeting of the British Association for the Advancement of Science, Professor Arnold, of Sheffield University, read a paper on August 23 in which he said that, to pass from generalities, through the kindness of his friend, Mr. J. T. Milton, Chief Engineer of Lloyd's, he was enabled to publish, with a certain degree of reserve, important facts ascertained during a two years' research carried out with the assistance of his friend and colleague, Mr. Andrew McWilliam, A. R. S. M., at the University College of Sheffield, under instruction from Lloyd's Committee.

To select one instance. The shell plates of the boiler of a colonial cruiser, split longitudinally from end to end, under the hydraulic test. The fractured plates were about 1 in. thick, and each weighed nearly three tons. The average analysis of the plates was about as follows: Carbon, 0.20; silicon, 0.02; manganese, 0.50; phosphorus, 0.04; sulphur, 0.04; copper and arsenic, very low. This analysis is beyond reproach. Pieces from the fractured plate, bent double and closed right up under violent hammering, without any sign of flaws. The average tensile tests registered about elastic limit, 15 tons per square inch; maximum stress, 29 tons per sq. in.; elongation, 29 per cent. on 2 in.; reduction of area, 50 per cent.

The above mechanical tests leave little to be desired. The microscopical structure showed a distinct and unusually sharp segregation of the pearlite and ferrite, the latter being angular and intensely crystallized. It was also large in pattern and frequently occurred in those long white lines, rich in sulphur and phosphorus which are technically known as "ghosts."

In the early stages of the research, it was thought that the sharp crystallization might be regarded as an effect due to that cause which produced also the effect of brittleness. As will be seen, presently, this theory was decisively negatived by subsequent experiments. In order to measure the mechanical brittleness incapable of being detected by ordinary static or bending tests, the author caused to be devised a machine by means of which the test piece is placed under severe rapidly alternating stresses, slightly beyond its elastic limit. The number of alternations are registered by a counter, adjusted to zero for each test. The rate of alternation can be varied at will and in the near future these data will be supplemented by a record of the energy expended per test piece, ascertained by means of a delicate, integrating watt meter.

This method of testing (which practically carries out the almost impracticable Wohler test in one or two minutes) has already thrown important light on the obscure phenomena under investigation and has also exhibited remarkable delicacy. These facts are proved by the data now submitted to the section by the author.

In preliminary tests on standard English acid open hearth boiler plate steel the remarkable fact was noted that in all probability the resistance of structural steel to rupture under rapidly alternating stresses is inversely proportional to the rate of alternation. This law, if fully established by the exhaustive experiments now being carried out at the Sheffield College, demands care-

ful attention from every engine designer. The following figures indicate concretely the data upon which the author provisionally enunciates the law. The subjoined table has reference to alternating shock bending tests carried out on a good boiler plate steel, the test bars being ⅝ in. square and the bending force being applied 4 in. from the line of maximum stress, with a range $^{9}/_{16}$ in. each side.

Mark.	Rate of alternation.	No. of alternations necessary to complete fracture.	Mean.
S 1	158 per min...	1,330	1,375
S 2		1,456	
S 3		1,352	
S 4		1,361	
S 5	266 per min...	860	378
S 6		870	
S 7		916	
S 8		868	

Whilst the above results exhibit considerable concordance, those obtained from the fractured boiler plate were so erratic that for a time the author was almost in despair, when the curious clue to the situation presented itself, that one side of the plate was brittle and the other tough under alternating stresses. This theory is about to be put to a more careful experimental test, but in the meantime the following data are, in all probability, substantially accurate:

Mark.	Alternations: Rate, per min.	Alternations: No. endured.	Heat treatment.	Probable position of test-piece.
L 3	168	420	Heated to 950°C. and cooled in air	Inside
L 4	168	1,232		Outside
L 7	168	1,378	Oil quenched from 950° C.	Outside
L 8	168	694		Inside
L 11	266	435	as received.	Inside
L 12	266	854		Outside
L 18	266	260	Heated to 950°C. and cooled in air	Inside
L 19	266	500		Outside
L 20	266	388	Annealed, heated to 950° C., slowly cooled.	Inside
L 21	266	781		Outside
L 22	266	630	Oil quenched from 950° C.	Outside
L 23	266	240		Inside
L 26	266	400	Water quenched from 900°; heated to 600°.	Doubtful.
L 27	266	336		

The somewhat disconcerting lessons to be drawn from the above table are: (1) That once a steel has assumed decisive brittleness in alternation, it cannot be restored by heat treatment of any kind short of re-melting; (2) That the injury to this steel was on one side of the plate, and hence due to unskilful reheating of the ingot, and not to an improper casting temperature, since the latter must necessarily have affected every portion of the plate. A third and still more regrettable confession has also to be made, namely, that the microstructures of the pairs, including both brittle and tough steel were in all respects identical, though of course that of each pair varied with the heat treatment to which they had been subjected.

Reminiscences of Early Railroading.

BY C. H. CARUTHERS.

During the latter part of the sixties, the writer attended school in the city of Pittsburg, for ten months of each year, and traveled each school day on the trains of the Pennsylvania Railroad between the city and his home—about 22 miles out. Deeply interested in railroad matters from early childhood, the impressions of those days of long ago are still vivid and afford many points of interesting comparison with twentieth century practice.

Until 1863, but few of the passenger engines burned coal, and instead the tenders were heaped high with cord-wood which was replenished as the supply diminished, from "woodsheds" at convenient intervals. One of these sheds was located at my home station and the conductors and brakemen always assisted the sawyer and fireman in loading this fuel on the tender, while the engineman (we called him "engineer," then) oiled and inspected his engine. These engines, as will be remembered by many, were painted in gaudy colors, and the tenders especially were profusely decorated with striping and arabesques in which gold-leaf and all the hues of the rainbow combined to evidence the painters' skill. Much polished brass also added to the brilliancy of the engines, and in some instances the domes, sandboxes, cylinders and steam chests were entirely encased with this metal.

The passenger coaches, on the contrary, were rather plain and the clear-story did not come into extensive use until about the latter part of 1863. Rosewood, mahogany, black walnut and bird's-eye maple composed the interior woods, but the windows were very small, and the headlining was a sort of oilcloth stamped with an exceedingly plain design. Except for a brief period, extending from 1862 to 1864, when compressed gas supplied light to three burners in each coach, but was quickly abandoned after an accident in the year last named, when the destruction by fire of the wrecked train, with the loss of many lives, was attributed to the gas, *two* sperm candles supplied the "illumination" for each coach! It can readily be seen that a night ride of any length was a rather dreary affair.

The crews wore no uniforms; only a badge indicating their ranks, and it was no unusual sight in warm weather to see a conductor resplendent in a suit of white, and wearing a broad-rimmed hat. Railroading was at that time still a comparatively new industry. In still earlier days men had naturally drifted from the stage coaches and the canal boats into the newer method of transportation, and had unfortunately brought with them many of the baleful habits such as drinking, profanity, gambling, and other vices, which characterized the lives of men in those earlier callings. Although the worst of such men were gradually dropped from the service, their influence had to an extent produced fruit in some of the younger men.

Length of service appeared to be the chief qualification in selection of men for handling special trains, thus when in 1860, the Prince of Wales, now King Edward VII., was to pass from Pittsburg to Philadelphia, an engineman was brought with his own engine, No. 166, from the Philadelphia Division, to haul the special over the road. It will be remembered that previous to 1857, the Allegheny Portage R. R., and the Columbia & Philadelphia had been the property of the State of Pennsylvania, and the employees had been given positions, and were retained in them, more on account of their efficiency in working for the dominant political party than for any especial ability in handling trains. This fact naturally tended to produce a class of employees somewhat similar to that evolved from the stage and the canal boat. Labor organizations as now known, did not exist among these men, but there was a sort of unwritten "comraderie" which found many ways of rendering burdensome the lives of the few who were trying to follow a higher plane of conduct. Neatness in personal appearance was ridiculed by these older men, and the engineman of to-day who skillfully and modestly handles his magnificent engine as he sits with cleanly-shaven face, white collar, neat tie, and gloved hands, would at that time have been a veritable Pariah among railroad employees.

There were days when the passenger equipment proved insufficient to meet an unexpected number of passengers, and at such times the conductor usually stopped at the first siding containing empty gondolas (this name was not then in use, such cars were known variously as flats or trucks) and attaching a sufficient number, seats having been hastily improvised of boards taken from the nearest pile kept to use at the doors in loading box cars with coal, the train went on and the occupants of these open cars enjoyed their ride, and incidentally the plentiful supply of sparks and cinders which rained upon them. Several times during the later years of the Civil War, all the coaches but one (retained for the use of women and children) of the accommodation on which my schoolmates and I made our daily trips, were taken to carry soldiers to the front, and after their return we soon had evidence, to the consternation of our mothers, that everything pertaining to army life had not been removed from these cars when the soldiers left them! Microbes, fumigation, germs, etc., were not then so much spoken of as at the present time.

The air-brake, as is known, did not come into use on regular trains until late in 1869, but from about 1862 we had the Loughridge continuous brake. This consisted of a transverse shaft behind the rear driver, having a chain attached to its center, and this chain was connected to the brakes of each coach, and was operated by a friction wheel on one end of the shaft, which at that end was carried in a sliding box, and this box was attached to a lever extending into the cab by means of which the friction wheel could be brought into contact with the flange of the driver and thus apply the brakes. This brake, owing to difficulty of taking up the slack chain, was of very little use on more than four cars from the engine. The chain often gave way when most needed, and then ensued a wild rush for the hand-brakes, on the part of the crew. Another type of power brake, known, I think, as the Cramer, and used for a number of years on the New York Central & Hudson River, was tried on a Pennsylvania coach, but did not impress the Altoona officials, nor anybody else, with its superiority to the Loughridge. Its principle was a powerful spring coiled in a drum about 18 in. in diameter by 6 in. deep. Each passenger car was provided with a spring so coiled, the whole using the vertical brake-shaft at one end as an axis to which it was connected in such a way as to permit its being wound up by turning the shaft the opposite direction to that used in braking by hand. A trigger and ratchet were placed on the top of the drum and from these a cord passed upward and was connected to the continuous signal rope of those days. In cases of emergency, the fireman was expected to pull the rope toward the engine, and this released the triggers and set the vertical shaft and its surmounting wheel to revolving furiously and thus set the brakes. A notice was placed on each car cautioning passengers to keep their hands off of the brake-wheels on account of possible injury from a sudden release of the spring. These drums were despised by the trainmen, as they were but a few inches above the ordinary ratchet, and when brakes were set by hand, the employee so using them often "barked his shins" as he moved his foot toward the pawl.

The average railroad passenger employee of to-day has but little idea of the real difficulties with which his predecessors of those days had to contend; and they did it, too, with but little, if any, complaint. With all their faults, they were generally a contented, happy-go-lucky set of men, kind under a rough exterior, and in the matters of correct living referred to, rather the subjects of environment than of premeditation. When that environment gradually changed for the better, a large number of these very men changed with it, and thereafter gave their hearty support to the efforts to maintain correct living among their fellows; so that the churches and the Young Men's Christian Association have found a large number of these older railroad employees among their most valued supporters.

GENERAL NEWS SECTION

THE SCRAP HEAP.

The Canadian Pacific is putting in apparatus by which to use telephones on its telegraph wires along the line of the road west of Winnipeg.

The Southern Pacific has oiled the roadbed for a distance of 42 miles on its Tucson (Arizona) division, and intends to thus lay the dust on 382 miles of line altogether.

Press reports state that about 30 persons were drowned in the recent flooding of the Pecos and Canadian rivers in Oklahoma and Indian Territory, the Pan Handle section of Texas and New Mexico. About a dozen bridges and many miles of railroad track were carried away.

On the night of October 10 most of the passengers in a sleeping car of the Missouri, Kansas & Texas were robbed of their valuables while asleep, between Sedalia, Mo., and Franklin Junction. It is said that the robbery was committed by a young man 22 years old, who chloroformed the porter and the other victims. The robber has been arrested.

To improve the speed of the fast freight trains on the Middle Division (Harrisburg to Altoona) the Pennsylvania has experimentally assigned to these trains regular engines and crews, four Harrisburg crews and six from Altoona having been selected for the service. There will be two engine crews to each engine and they will use the engine alternately, a round trip taking about 24 hours. The engines are class F3b, designed for fast freight trains.

The United States District Court at Atlanta, Ga., has set October 27 as the day for hearing the suits brought by the railroads to enjoin the Georgia State Railroad Commission from making a large reduction in freight rates which the Commission has promulgated. A temporary injunction in favor of the Central of Georgia was granted some time since, but all of the principal roads in the State are now interested, the others having been admitted as parties to the suit.

Mr. F. B. Fogg, Industrial Agent of the Missouri Pacific, has fitted up an "educational car" which is to be taken to county seats throughout the lines of the company with a view to instructing farmers in the best methods of agriculture and stock raising. It is proposed to stop the car one day at each county seat, and to advertise in advance so as to attract the farmers to the railroad station on that day. The car contains a varied exhibit of agricultural and mineral products from all the States traversed by Missouri Pacific lines.

M. C. B. and M. M. Association's Ballots.

The letter ballot of the Master Car-Builders' Association on changes in Standards and Recommended Practice which closed Sept. 25, resulted in the adoption of all of the five proposed changes in the standards of the association and the adoption of 17 of the proposed changes in the Recommended Practice. The changes rejected were, distance between center of bolster and face of end sill, use of two belt rails, height and width of cars on high trucks, lettering on end facia boards, specifications for air-brake hose. All of the 120 rules for loading long materials were adopted as revised at the last convention in June.

The Master Mechanics' Association letter ballot which closed September 16 resulted in the adoption as Recommended Practice of the revised specifications for boiler and fire-box steel, and for iron and steel boiler tubes. The new air-brake and signal instructions were also adopted.

Tests of Electric Locomotives for the New York Central.

The first of the 40 electric locomotives for the electric service of the New York Central which are being built by the American Locomotive Company and the General Electric Company, has been completed, and it is hoped to begin a series of tests with it in a few days. A stretch of track four miles long on the New York Central near Schenectady has been equipped with third-rail, and later this will be extended two miles so that runs can be made at maximum speed. The General Electric Company has installed a sub-station about five miles from Schenectady connected with the Speir's Fall power house, and alternating current will be taken at 10,000 volts and delivered as direct current at 600 volts to the third-rail. Tests will be carried out to determine the maximum speed, tractive effort and acceleration under the most severe conditions. These locomotives were described in the *Railroad Gazette*, June 3, 1904.

Discrimination by Closing Freight Houses Early.

The Interstate Commerce Commission in an opinion by Chairman Knapp, has announced its decision in the case of the Cincinnati Chamber of Commerce and Merchants' Exchange against the Baltimore & Ohio Southwestern and other roads centering in Cincinnati. The complaint was against the rule changing the hour of closing freight houses from 5 to 4.30 o'clock except Saturday, and from 1 to 12.30 on Saturdays. The Commission holds that its jurisdiction extends to a case of alleged unlawful disadvantage to shippers of outbound package freight through enforcement of such a regulation; but a rule for early closing which prevents congestion of freight in the receiving depot is as much to the advantage of the shipper as a later hour would be in enabling him to place his freight in the depot and the carriers are apparently doing the best they can in their present circumstances. On the other hand, the large and growing volume of freight indicates the necessity of strenuous efforts to remove any existing hardship to the shippers through their inability, under the early closing rule, to compete on even terms with shippers in other distributing cities. The decision is that the existing disadvantage to Cincinnati shippers, under present circumstances, is not unreasonable or undue, but may become so if the present condition is continued indefinitely.

Hearing on Private-Car Abuses.

At Chicago this week the Interstate Commerce Commission held an investigation of alleged abuses in the use of private cars. Mr. J. W. Midgley cited instances intended to show that all the railroads of the country are in the grasp of the "private car line trust," and that any road or shipper standing in the way of the monopoly is mercilessly destroyed. The entire refrigerator service was declared to be in a trust. The companies not only insist upon exclusive contracts, but also demand high mileage from the railroads, and thereby make 20 to 25 per cent. on their investments.

The attorney for Street's Western Car Line contended that the car concern was not a common carrier, and that its officers need not divulge its methods of business. A Cincinnati fruit merchant testified that Armour & Co. sold pineapples in Cincinnati at prices which could not possibly be met by competitors in order to coerce produce dealers into using the Armour refrigerator cars. He produced evidence tending to show that the Armour refrigerator line exacted $35 for hauls for which other companies charged only $5. J. S. Leeds, Manager of the Santa Fe Fruit Despatch, was asked "Did you ever give shippers rebates?" "Well, in northern California we gave the shippers a remittance of $25 on each car. We had to do it to compete with the Armour line."

Electrifying the Colorado & Southern.

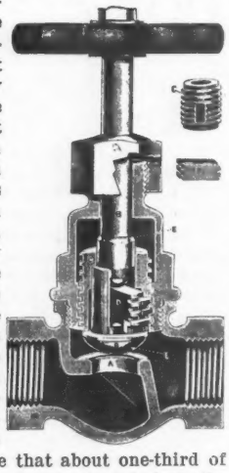
Plans are being made for electrifying a part of the Colorado & Southern Railroad and preliminary work has already begun to put the line in shape for the electric service. The Denver & Interurban Company is an organization of Colorado & Southern officers, which proposes to build, equip and operate electric roads, etc., in the State of Colorado. Its present plan is to electrify the existing line of the Colorado & Southern between Denver and Boulder, a distance of 30 miles, for passenger service only. In the immediate future, it is proposed to build a line within the limits of the City of Denver on some of the principal business streets, and later on to apply for a general franchise in the city. Future plans provide for making extensions into the farming communities north of Denver, and also equipping other Colorado & Southern lines running out of Denver.

The present plan contemplates the location of a power house at one of the coal mines half way between Denver and Louisville, using lignite slack, costing about 50 or 60 cents a ton. Power can thus be generated at a low cost. A single-phase alternating current system will be used with 20,000 volts on the feeder line and 3,000 volts on the trolley line. The cars will be 55 ft. long, carrying 60 passengers, and will weigh from 35 to 38 tons. It is intended to start with a half-hourly service out of Denver. The line will branch at a point about 19 miles from Denver, one line running to Boulder and the other to Louisville and La Fayette and the mining districts. The run of 30 miles from Denver to Boulder, it is expected, will be made in 50 minutes, including 11 stops, the motors and equipment being designed for a speed of 60 miles an hour. Estimates have already been furnished by the electric companies for the construction of this part of the line, and next week the Colorado & Southern will commence ballasting its line between Denver and Boulder and will put it in shape for the electric service.

The freight business and passenger business of the Colorado & Southern will be done on the same line, but the electric service will not interfere with the freight service to any extent, as 16 miles out of Denver there is a loop line, over which freight trains will be run, entirely independent of the electric cars and passenger trains. Beyond this point there will be about five miles of double track, built so that freight and electric service will only be on a common track for about 11 miles.

Self-Grinding Globe Valve.

A new design of self-grinding, self-seating and non-leaking globe valve is shown in the accompanying illustration. The stem is surrounded just above the valve by a threaded sleeve or jacket and that part of the stem which is within the jacket is formed with an opening through it. A plug or key passes through the sleeve and the opening in the stem and the ends of this key are threaded to fit the thread on the sleeve. The opening in the valve stem is of such size that about one-third of a turn of the stem is required before the threaded sleeve starts to move. When the valve is closed the sleeve acts as a lock nut to hold it on its seat. This fractional turn of the valve before the sleeve moves in opening and therefore before the valve leaves its seat, makes the valve self-grinding. The parts of the valve are made of the best steam metal for high pressures. The Burlington Brass Works, Burlington, Wis., is the maker.



Manufacturing and Business.

The Chandler & Taylor Co., of Indianapolis, Ind., it is reported, will build a boiler shop 110 ft. x 180 ft.

The Covington Machine Shops, at Covington, Ga., reports say, have been sold to E. C. Rainey, of Eatonton, and will be enlarged.

The Seamless Tube Co. of America, reports say, is planning to build new works at Monessen, Pa., and has increased its capital stock from $500,000 to $1,000,000.

The United Engine & Power Co., of New York, has been incorporated with a capital of 300,000. The directors are Rudolph Brettner, G. Bondy and others, of New York.

The Columbia Tool Steel Co., it is reported, is having plans made for putting up several brick and steel buildings, to include a main shop 75 x 650 ft., at Chicago Heights, Ill.

The Philadelphia Rapid Transit Co., it is reported, has given a contract for building its new machine shop and will soon be in the market for the necessary equipment.

Bids are wanted October 27 by B. Leighton Beal, Secretary of the Boston Transit Commission, for building section 1 of the Washington street tunnel, near Bennet and Kneeland streets, Boston.

A special commissioner of the Chilian Government, Mr. Varella, is at the office of *El Americano*, 90 Wall street, New York, and is said to be about to order railroad material aggregating about $5,000,000.

The Lawrence Pump & Engine Co., of Lawrence, has been incorporated in Massachusetts with a capital of $24,000. Hiram L. Mellor is President and Francis A. Hall, Treasurer, both of Lawrence.

The Ravenswood Marine Equipment Co., of New York, has been incorporated with a capital of $125,000. The directors are: Frank Drew, H. L. Desanges, of Flushing, and H. S. Rekert, of New York.

Bids are wanted by the village board of Kiel, Wis., October 26 for a 75-ft. steel tower, a 60,000-gallon steel tank, one centrifugal rotary pump, one high lift turbine pump, and a 25-h.p. gasoline engine. W. G. Kirchoffer is Engineer.

Press reports from Cleveland say that the Pittsburg Steamship Co., which is the marine branch of the United States Steel Corporation, will soon place orders for five new steel freight carriers each 500 ft. long, to be ready for delivery at the opening of navigation in 1905. The United States Steel Corporation is planning to carry all of its own ore and will require about nine steamers for use on the lakes.

Stephen J. Bowling has resigned as President, General Manager and Director of the C. B. Hutchins & Sons Car Roofing Co., Detroit, Mich., to accept the presidency of a new company now being organized to make all classes of plastic and metal freight car roofs. The name and headquarters of the new concern have not yet been announced. The business of C. B. Hutchins & Sons will be under the direction of Benjamin S. Warren, Vice-President and General Manager, until further notice.

Vice Chancellor Stevens at Newark, October 6, on the application of Robert E. Jennings, of New York, receiver of the Carpenter Steel Co., of Pennsylvania, signed an order appointing October 19 as the date on which objections will be heard from stockholders to the reorganization plans, which provide for a new company with a capital of $1,200,000. It is proposed to issue $250,000 5 per cent. 10-year gold bonds with which to pay for all claims of dissenting stockholders, the balance to be used to pay the expenses of the receiver and for the reorganization.

The Northern Electrical Mfg. Co., of Madison, Wis., recently shipped to the New York Edison Co., 34 of its variable speed motors operating on the Northern two-wire field control system. These motors will be directly coupled to blowers for cooling the transformers in the various sub-stations of the company. Nine small Northern motors to be used in the sub-stations of the Brooklyn Rapid Transit Co. have also been shipped. This makes a total of 75 Northern motors now in use by the two companies aggregating 1,500 h.p. A 60 k.w. Northern balancing set has been shipped to the New York Edison Co. for the equipment of its Waterside station.

Iron and Steel.

The Sligo Iron & Steel Co., reports say, is planning improvements at its Connellsville, Pa., works, to include the rebuilding of a bar mill at a cost of about $40,000.

The National Tube Co. at McKeesport, Pa., it is reported, is rebuilding its entire finishing department. The building containing the threading department has been recently removed a distance of 300 ft. without suspension in operations and the ground vacated is to be occupied by a new 12-in. mill.

Press reports from Denver state that the Minnequa Steel Works of the Colorado Fuel & Iron Co. has been given a contract for 800 miles of rails for the Western Pacific Railway. At these works, the production now is 600 tons a day and this will soon be doubled. The entire plant is now running on full time.

It is reported that the Steel Foundries Co. has bought a controlling interest in the Commonwealth Steel Co., which has an authorized capital of $1,000,000 and a monthly capacity of 3,000 tons of open-hearth steel. Its works are at Granite City, Ill. T. K. Niedringhaus, recently elected a director of the American Steel Foundries Co., was interested in this company.

MEETINGS AND ANNOUNCEMENTS.

(For dates of conventions and regular meetings of railroad conventions and engineering societies see advertising page 24.)

American Railway Association.

The fall session of this association is to be held at the Bellevue-Stratford Hotel in Philadelphia, Pa., October 26. At this meeting there will be an election for First Vice-President and for three members of the committees on car service and on safety appliances. Reports from the committees on train rules, car service, safety appliances and statistical inquiry will be submitted.

PERSONAL.

—Colonel H. G. Prout, First Vice-President and General Manager of the Union Switch & Signal Company, and former editor of the *Railroad Gazette*, has been elected a Director of the Westinghouse Air-Brake Company, to fill the vacancy caused by the death of the late Henry Oliver.

—Mr. William Cotter, the new General Manager of the Pere Marquette at Detroit, has, for the past two years, been Manager of the Missouri Pacific. Mr. Cotter's railroad career dates from 1874, when he began as a telegraph operator on the Chicago & Alton. He remained with that company for four years, when he resigned to enter the

service of the St. Louis, Iron Mountain & Southern as an operator at Piedmont. He was train despatcher and trainmaster on the same line at Little Rock in 1880. Two years later he went to La Crosse, Wis., where for one year he worked for the Chicago, Milwaukee & St. Paul, and from there he went to Litchfield, Ill., where for 13 years he was on the Wabash, the last six years as Trainmaster of the St. Louis Division. In 1896 he went to Montreal, Canada, as Superintendent of the Eastern Division of the Grand Trunk; in 1899, he was transferred to Detroit as Superintendent of the Western Division, but later resigned and again entered the service of the Iron Mountain, as General Superintendent at St. Louis. In 1902, Mr. Cotter was appointed Manager of the Missouri Pacific, which position he left on the first of this month to go to the Pere Marquette as above.

—Mr. Charles W. Anderson, Assistant Superintendent of the Western Division of the Boston & Maine, died, suddenly, at his home in Malden, Mass., on October 3, at the age of 46. Mr. Anderson had for a number of years been station agent at Fitchburg, and a little over a year ago had been promoted to the position he held at the time of his death.

—Mr. Albert W. Sullivan, who has gone to St. Louis to succeed Mr. Harding as General Manager, in charge of operation, of the Missouri Pacific, leaves the Illinois Central after a continuous service of 34 years. At the age of 16 he entered the shops in Chi-

cago as a machinist apprentice, and after serving three years as mechanical draughtsman and four years as chief clerk in the machinery department, was appointed Assistant Superintendent of Machinery. Later he was appointed Superintendent of the lines in Illinois, and in 1889, he was made General Superintendent. He was promoted to the position of Assistant Second Vice-President in 1901. Mr. Sullivan is a Past President of the American Railway Association, and as such was recently elected to membership in the American Section of the International Railway Congress.

—Mr. A. S. Begg, Superintendent of Terminals of the Grand Trunk at Port Huron, Mich., was killed by suffocation in the St. Clair Tunnel on October 9. Five other men lost their lives at the same time and an account of the circumstances of their death will be found in another column.

—Mr. E. B. Boyd, who recently resigned as General Freight Agent of the Chicago, Rock Island & Pacific, has become Traffic Director of the Chicago Board of Trade. Mr. Boyd had been in the service of the Rock Island for a number of years. In 1892 he was appointed Second Assistant General Freight Agent, and then successively First Assistant General Freight Agent; General Freight Agent of the lines west of the Missouri river, and from 1899 to the present time, General Freight Agent of the lines east of the Missouri river.

—Mr. Walter B. Calloway, who succeeds Mr. L. M. Webb as Assistant General Passenger Agent of the Cincinnati, Hamilton & Dayton, was formerly General Passenger Agent of the Chicago, Cincinnati & Louisville, and is about 30 years old. His railroad service began in the passenger department of the Cleveland, Cincinnati, Chicago & St. Louis in 1891. In 1898 he left the Big Four to go to the Cincinnati, Hamilton & Dayton as rate clerk. A year later he was made chief rate clerk, and in 1900, was made advertising manager. In 1902 he left the service of this company to become Assistant General Passenger Agent of the Cincinnati, Richmond & Muncie (Chicago, Cincinnati & Louisville), and in 1903 was appointed General Passenger Agent.

—Mr. Job Adolphus Edson, who has been appointed General Manager of the Cincinnati, Hamilton & Dayton (recently merged with the Pere Marquette), has for some time past been Manager of the Denver & Rio Grande. Mr. Edson is a native of Ohio, and is 50 years old. He was born in Sylvania, and entered railroad service in 1867, as a telegraph operator on the Lake Shore & Michigan Southern. In 1872 he went to the Union Pacific as chief despatcher and remained there for fourteen years. From the U. P. he went to the Chicago, Milwaukee & St. Paul, but soon left, and in 1887 was made Superintendent of the Western Division of the Missouri Pacific. Two years later he held a similar position on the St. Louis Southwestern, and in 1892 was promoted to be Superintendent of the entire Cotton Belt system. The next year he was made General Superintendent. In 1899 he went to the Kansas City, Pittsburg & Gulf, and thence to Denver as Manager of the Denver & Rio Grande. As General Manager of the Cincinnati, Hamilton & Dayton Mr. Edson's office will be in Cincinnati.

—Mr. Frank Hedley, the new General Manager of the Interborough Rapid Transit Company (New York), operating both the Manhattan elevated lines and the Subway, was promoted from the position of General Superintendent. Mr. Hedley was born in 1861 at Maidstone, Kent, England, and when 13 years old was apprenticed as a mechanical engineer. After completing his apprenticeship, in 1881, he came to the United States. His first position was in the Jersey City shops of the Erie Railroad. About 18 months

later he went to the New York Central & Hudson River, where he remained a few weeks, and then went to the Manhattan, soon becoming inspector on the Third Avenue Division, and later General Foreman of the west side divisions. He next went to the Kings County Elevated, Brooklyn, where he was Master Mechanic; and he remained with that company until called to be General Superintendent of the Lake Street Elevated at Chicago. Mr. Hedley returned to New York as General Superintendent of the Interborough Rapid Transit Company in January, 1903, from which position he is now promoted.

—Mr. Charles C. Riley, who recently succeeded Mr. Mozier as Superintendent of Transportation of the Erie, is 40 years old, and was educated at the Butler University at Indianapolis, Ind. Mr. Riley's railroad service began on the Cleveland, Cincinnati, Chicago & St. Louis as yard clerk, and he was successively station agent and chief clerk. From 1897 to 1900 he was Superintendent of Car Service and Superintendent of Transportation on the Baltimore & Ohio Southwestern, and during the following year (1900-1901) he was an instructor in the College of Physicians and Surgeons at Indianapolis. In the latter year (1901) he again entered railroad service and for a time was Car Service Agent on the Chicago Great Western, but he soon left this road to go to the Erie as Superintendent of Car Service, from which position he is now promoted to be Superintendent of Transportation at Jersey City.

ELECTIONS AND APPOINTMENTS.

Atchison, Topeka & Santa Fe.—A. H. Gairns, hitherto Master Mechanic of the Chicago, Rock Island & Pacific at Trenton, Mo., has been appointed General Foreman in charge of the San Bernardino shops of the A., T. & S. F.

Baltimore & Ohio Southwestern.—J. C. Hagerty, hitherto Trainmaster, has been appointed Superintendent of the Indiana Division, with headquarters at Cincinnati, O., succeeding W. B. Poland, resigned.

Canadian Pacific.—S. King, hitherto Master Car Builder of the Intercolonial, has been appointed Assistant Master Car Builder of the C. P.

Chicago, Cincinnati & Louisville.—The jurisdiction of A. H. McLeod, Freight Traffic Manager of the Cincinnati, Hamilton & Dayton, has been extended over the C., C. & L.

See Cincinnati, Hamilton & Dayton.

Chicago, Milwaukee & St. Paul.—B. F. Van Vliet, Division Superintendent at Des Moines, Iowa, has been transferred to Minneapolis, Minn., as Superintendent of the Hastings and Dakota Division.

Cincinnati, Hamilton & Dayton-Pere Marquette.—J. A. Edson, hitherto Manager of the Denver & Rio Grande, has been appointed General Manager of the C., H. & D., with headquarters at Cincinnati, Ohio.

Walter B. Calloway, General Passenger Agent of the Chicago, Cincinnati & Louisville, has been appointed Assistant General Passenger Agent of the C., H. & D., with headquarters at Cincinnati, Ohio, succeeding Lewis M. Webb, resigned, effective Nov. 1.

At a meeting held Oct. 11, C. A. Otis, Jr., A. Skitt and A. Turnbull were elected Directors.

(See Chicago, Cincinnati & Louisville.)

Colorado & Wyoming.—J. F. Welborn has been appointed Vice-President and Traffic Manager of this company and the Crystal River, with headquarters at Denver, succeeding C. A. Parker, resigned.

Denver & Rio Grande.—See Cincinnati, Hamilton & Dayton.

Evansville & Terre Haute.—G. H. Bussing, hitherto Assistant Superintendent of Motive Power, has been appointed Superintendent of Motive Power.

Illinois Central.—W. L. Smith has been appointed Assistant to the Second Vice-President, with office at Chicago, of this company and the Yazoo & Mississippi Valley. The position of Assistant Second Vice-President, formerly held by A. W. Sullivan, has been abolished.

Intercolonial.—S. King, Master Car Builder, has resigned. (See Canadian Pacific.)

International & Great Northern.—Homer Eads, hitherto Superintendent of Car Service at Palestine, Texas, has been appointed Assistant General Freight Agent, with headquarters at San Antonio, succeeding W. C. Rigsby. The position formerly held by Mr. Eads has been abolished.

Manistee & Grand Rapids.—At a meeting of the Board of Directors held Oct. 5, the following officers were elected: J. Crocker, President, Chicago, Ill.: Max Toltz, Vice-President and General Manager, Manistee, Mich.; W. M. Simpson, Secretary; B. C. Sammons, Treasurer, and C. E. Pain, Counsel, Chicago. J. W. Murray has been appointed General Freight and Passenger Agent, with headquarters at Manistee, Mich.

Mississippi Central.—R. M. Boldridge has been appointed Master Mechanic, with headquarters at Hattiesburg, Miss., succeeding C. H. Welch, resigned.

Mobile, Jackson & Kansas City.—G. W. Carye has been appointed Secretary and Treasurer, with office at Mobile, Ala., succeeding P. C. Butler, resigned.

New York Central & Hudson River.—D. W. Dinan, hitherto Trainmaster, has been appointed Assistant Superintendent, with office at Jersey Shore, Pa.

M. C. Roach, hitherto General Eastern Passenger Agent, has been appointed Assistant General Passenger Agent, with office in New York City.

Philadelphia & Reading.—R. Atkinson, Master Mechanic at Reading, Pa., has resigned.

Reading Company.—H. C. Frick and H. McK. Twombly have been elected Directors, succeeding the late John Lowber Welsh and H. P. McKean, respectively.

St. Louis & San Francisco.—E. F. Kearney, General Superintendent of Transportation; W. H. Williams, Superintendent of Freight, Transportation, Yard and Station Service; J. H. Elliott, Superintendent of Passenger Transportation, and C. H. Miller, Superintendent of Distribution of Power and Cars, have resigned, and the offices have been abolished. The duties of these offices will be assumed by the General Manager. Mr. Elliott has been appointed Superintendent of Mails.

St. Johns River Terminal.—W. L. Pierce has been appointed Superintendent, with headquarters at Jacksonville, Fla., succeeding W. L. Williamson.

Southern Pacific.—C. B. Seger has been appointed Auditor of the Pacific System, with headquarters at San Francisco. E. S. Benson, Auditor of the Oregon lines, will succeed Mr. Seger as Auditor for the S. P. lines in Texas, with headquarters at Houston.

Union Pacific.—W. G. Rockefeller and H. C. Frick have been elected Directors, succeeding H. G. Burt and Louis Fitzgerald.

United New Jersey R. R. & Canal Cos.—P. N. Jackson has been elected a Director, succeeding his father, the late F. Wolcott Jackson.

Wheeling & Lake Erie.—W. M. Bonar, hitherto Freight and Ticket Accountant, has been appointed Acting Auditor.

Yazoo & Mississippi Valley.—See Illinois Central.

LOCOMOTIVE BUILDING.

The Detroit United Railway is having one locomotive built at the Rogers Locomotive Works.

The Vera Cruz & Pacific is reported to have ordered six locomotives from the Baldwin Locomotive Works.

The Mexican Coal & Coke Company is having one locomotive built at the Baldwin Locomotive Works.

The Chicago, Milwaukee & St. Paul expects to build some passenger locomotives at its West Milwaukee shops.

The Pennsylvania Lines West are reported to have placed orders for 25 locomotives to be built at the Altoona shops.

The Toledo, St. Louis & Western has ordered 10 simple 10-wheel (4-6-0) locomotives from the American Locomotive Co. Specifications for these engines were published in our issue of September 23.

The Canadian Pacific, as reported in our issue of September 23, is having 20 simple consolidation (2-8-0) locomotives built at the Schenectady works of the American Locomotive Co. for delivery in October and November, 1904. The locomotives will weigh 182,000 lbs., with 157,000 lbs. on drivers; cylinders, 21 in. x 28 in.; diameter of drivers, 57 in.; radial stayed boiler, with a working steam pressure of 200 lbs.; 244 2-in. tubes and 22 5-in. tubes 14 ft. 4½ in. long; steel fire-box, 96 in. x 66 in.; grate area, 44 sq. ft.; tank capacity, 5,000 gallons of water, and coal capacity, 12 tons. The special equipment includes: Open-hearth axles, "Little Giant" bell ringers, Magnesia boiler lagging, Simplex brake-beams, C. P. R. standard brake-shoes, Washburn couplers in front and Tower couplers in the rear, Pyle-National electric headlights, Hancock No. 10 injectors, U. S. metallic piston rod and valve rod packings, Leach sanding devices, crucible steel springs, Utica steam gages, cast-steel wheel centers, Schenectady superheater and combined automatic and straight air-brakes.

CAR BUILDING.

The Tennessee Central denies being in the market for 700 coal cars.

The Rutland Railroad denies that it is in the market for equipment.

The American Car & Foundry Company has miscellaneous orders for seven cars.

The San Pedro, Los Angeles & Salt Lake is in the market for some passenger cars.

The Swift Refrigerator Transportation Company is asking bids on 200 stock cars.

The Pennsylvania, as reported in our issue of October 7, is in the market for 200 coke cars.

The Wheeling & Lake Erie has ordered 1,000 coal cars from the American Car & Foundry Co.

The Rodger Ballast Car Company has ordered 30 class F. H. cars from the American Car & Foundry Co.

The German-American Car Company, Chicago, has ordered 1,500 refrigerator cars from the Standard Steel Car Co.

The Cincinnati, Hamilton & Dayton will place an order for some new passenger equipment during the winter for next spring and summer use.

The New York Central & Hudson River has ordered 1,500 box cars from the Western Steel Car & Foundry Co. and 1,500 drop bottom gondolas from the American Car & Foundry Co. The company is also reported in the market for 2,000 steel cars in addition to the orders placed above.

The Cincinnati Traction Co. has ordered 50 semi-convertible cars from the Cincinnati Car Co. These cars will weigh about 19,000 lbs., and measure 20 ft. 6 in. long, over corner posts; 8 ft. 1¼ in. wide and 8 ft. 7 in. high from bottom of sill. The special equipment includes: Consolidated Car Heating Co.'s heating system.

The Southern has ordered 1,000 steel coal cars of 100,000 lbs. capacity from the American Car & Foundry Co. These cars will weigh 38,000 lbs., and measure 30 ft. long, 10 ft. wide and 10 ft. high. The special equipment includes: Damascus brake-beams, Westinghouse air-brakes, Southern Railway standard brasses and American Car & Foundry Co.'s 700-lb. M. C. B. wheels.

The Central of Georgia has ordered 500 ventilated box cars of 60,000 lbs. capacity from Haskell & Barker. These cars will weigh 34,200 lbs. (estimated), and measure 36 ft. long, 8 ft. 6 in. wide and 8 ft. high, all inside measurements. The special equipment will include: Simplex brake-beams, Westinghouse air-brakes, Jones doors, Central of Georgia standard paint, standard arch-bar trucks and M. C. B. cast iron wheels.

BRIDGE BUILDING.

ANNAPOLIS, MD.—Bids are wanted by the County Commissioners November 1 for building an iron bridge over Patapsco River to replace the present wooden structure known as the Sweetser bridge. Charles Himelherber is Clerk.

CHICAGO, ILL.—Bids are wanted November 4 by Col. O. H. Ernst, U. S. Engineers, for rebuilding the substructure and for flooring a bridge at Calumet Harbor, Ill.

CINCINNATI, OHIO.—Bids are wanted October 29 by the Board of County Commissioners for building a bridge and abutments on the East Maimi river road in Colerain Township.

FORT WORTH, TEX.—Press reports state that the bridge of the Fort Worth & Denver City over the Canadian river at Tascosa, the bridge of the Rock Island on the line of its road between Logan and Tucumcari, and the Pecos Valley bridge, have been carried away by high water.

FREDERICTÓN, N. B.—Bids are wanted by the Commissioner of Public Works for the substructure and superstructure of the New River Mills bridge, in Restigouche County.

GOLDSBORO, N. C.—The Howland Improvement Co., which now leases the Atlantic & North Carolina Railroad, reports say, will build a steel bridge over Stony Creek near this place; also one over the stream near New Bern to replace the present structures.

HAGERSTOWN, MD.—Bids, it is reported, are wanted October 18 by Washington County Commissioners for building a steel bridge on stone foundation. John E. Wagaman is Clerk.

INDIANAPOLIS, IND.—Bids are wanted October 17 by the Board of Public Works for building a concrete steel bridge over Pleasant Run at East Washington street to cost about $12,000; also for a bridge over White river at Morris street. M. A. Downing is a member of the board.

NEWPORT, IND.—The Lafayette Engineering Co., of Lafayette, Ind., it is reported, has been given a contract at $20,000 for building the substructure of the Cayuga bridge over the Wabash river.

NEW YORK, N. Y.—Bids are wanted October 25 at the office of the Aqueduct Commissioner for building a private road bridge with a superstructure 150 ft. long over the Croton river, below the new Croton dam in the town of Cortland, Westchester County. W. H. Ten Eyck is President.

PAWNEE CITY, NEB.—Bids are wanted by the Board of County Commissioners November 4 for furnishing all the material and building all bridges that may be needed in Pawnee County for one year from December 1. J. M. Hurd is County Commissioner.

PHILADELPHIA, PA.—The Mayor has vetoed the ordinance appropriating $500,000 for building a bridge over the Schuylkill river at Passyunk avenue, and recommends the building of the following bridges: At Allen's Lane over the Wissahickon Creek; Wyoming avenue, over Frankford Creek; a new west bridge to the Spring Garden street bridge; Front street, over the connecting railroad; Large street, under the Frankford branch of the Philadelphia & Reading; Sedgeley avenue, over the Richmond branch of the Philadelphia & Reading; Montgomery avenue, near the connecting railroad; Cresson street, over Midvale avenue; Willow Grove avenue, over Germantown avenue, and Bellifield avenue, under the Tabor branch of the Philadelphia & Reading.

ST. CATHARINES, ONT.—L. K. Jones, Secretary Department of Railways and Canals, is receiving bids for a new steel bridge crossing the Welland Canal at Niagara street in this city. Plans at the office of the Superintending Engineer.

SMITHVILLE, ARK.—Bids are wanted October 20 by L. B. Poindexter, County Judge, for building a steel bridge over the Strawberry river in Lawrence County, to consist of one span 90 ft. long on steel tubular piers filled with concrete 34 ft. high and 3 ft. in diameter, two at each end of the bridge about 13 ft. apart, if built at Taylor ford; or for a similar bridge with piers 36 ft. high and 144 ft. of steel trestle if built at Jones Mill ford.

STEUBENVILLE, OHIO.—The Pittsburg, Cincinnati, Chicago & St. Louis, according to reports, will shortly build a four-track rail-

road bridge over the Ohio river a short distance above the present bridge.

SYRACUSE, N. Y.—The State, it is reported, will at once build the Coldspring bridge over Seneca river at a cost of about $20,000.

TIPTON, IOWA.—It is said that bids are wanted November 15 by the Board of County Supervisors for building and repairing bridges in Cedar County for the year 1905. W. H. Hamm is Auditor.

Other Structures.

BISBEE, ARIZ.—The El Paso & Southwestern, it is reported, has given a contract for building large shops here.

GULFPORT, MISS.—The Gulf & Ship Island, it is reported, will spend about $500,000 in improvements, including a pier 3,340 ft. long and 40 ft. wide, of creosoted timber; also a warehouse 100 x 300 ft.

HAMILTON, ONT.—The shops of the Toronto, Hamilton & Buffalo were damaged by fire October 4; loss about $35,000.

HAVELOCK, NEB.—The Chicago, Burlington & Quincy, reports say, is planning large additions to its shops in the spring to increase their capacity. The machine and boiler shops will be enlarged and a large amount of new machinery is to be added.

LOUISVILLE, KY.—The first of the new Louisville & Nashville shops in South Louisville has been put in operation. All of the shops, which cover approximately 60 acres, are under roof and will cost, with the machinery to be put in, about $2,250,000 when completed. It is expected that the rest of the shops will be in operation by the first of next year.

MARYSVILLE, PA.—Arrangements, it is reported, have been completed by the H. S. Kerbaugh Co., Inc., of Philadelphia, for 27 acres of land in Marysville, on which it will build large shops for repairs and to make machinery used by the company in fulfilling its various contracts with the railroads.

MERIDIAN, MISS.—It is reported that plans for the new union passenger station have been completed.

NEW WESTMINSTER, B. C.—The Great Northern, according to reports, intends building car shops at this place.

OKLAHOMA CITY, OKLA. T.—The Oklahoma City Street Railway Co., reports say, has given a contract to the Gross Construction Co. for building a brick car barn 80 ft. x 170 ft., with a fireproof roof, to cost about $20,000.

POINT ST. CHARLES, QUE.—The Grand Trunk, it is reported, has options on land as a site for new shops to cost about $200,000.

PORTLAND, ORE.—The Northern Pacific Terminal Co., reports say, will build a train shed to cost $60,000 at the union station.

ROCKY MOUNT, N. C.—The Atlantic Coast Line has given a contract to D. J. Rose & Co. for a brick addition 214 x 100 ft. to its shops at South Rocky Mount.

SEATTLE, WASH.—The contract for the new union passenger station to be built jointly by the Great Northern and Northern Pacific, has been given to Deeks & Deeks, of St. Paul, at about $400,000.

TRINIDAD, COLO.—The Atchison, Topeka & Santa Fe, it is reported, will at once rebuild the station at this place which was carried away by flood.

RAILROAD CONSTRUCTION.

New Incorporations, Surveys, Etc.

ATCHISON, TOPEKA & SANTA FE.—An officer writes denying the report that this company is planning to build an extension from Tulsa, Ind. T., southwest to Shawnee, Okla. T., 70 miles. Bids will be received until October 20, however, for building a line from Owasso, Ind. T., to Tulsa, 12 miles. The present southern terminus of the A., T. & S. F. is Owasso. Woodbury Howe, Assistant Engineer, will be in charge of the work. (September 30, p. 116.)

BALTIMORE & OHIO.—Official announcement is made of the opening of seven miles of new main line between Youngstown, Ohio, and Akron, on the Pittsburg division. The section between Kent and Ravenna, about seven miles, is expected to be ready for operation by the end of November, while that portion between Ravenna and Haselton, 43 miles, will be ready about January 1.

BAY MINETTE & FORT MORGAN.—Press reports state that rights of way have been secured for this proposed road from Bay Minette, Ala., in a southerly direction to Fort Morgan, 45 miles. Work is in progress and the first 10 miles out of Bay Minette have already been graded. It is the intention of the company to have the line completed by January 1 if possible. W. W. Olney, Bay Minette, Ala., is Chief Engineer. (July 22, p. 41.)

CANADIAN PACIFIC.—W. F. Tye, Chief Engineer, who has just returned to Montreal after a trip to the west, is reported as saying that the most importannt improvement in the engineering department is the reduction of grades between Swift Current and Moose Jaw and between Winnipeg and Fort William. These grades have been reduced from 50 ft. per mile to 20 ft. per mile.

DELTA SOUTHERN.—An officer writes that the proposed route of this road is from Elizabeth, Miss., in a northerly direction to Kuhns, 25 miles, with a branch line from Elizabeth south to Campbellsville, in Yazoo County, 20 miles. Grading is now in progress on the first 11 miles out of Elizabeth towards Kuhns. The contractors are Jones & Brewer, of Birmingham, Ala. The work is light, with a maximum grade of .8 per cent. There will be no steel bridges or important trestles. W. H. Wells is the engineer in charge of the work, and J. S. B. Thompson, Atlanta, Ga., is President. (September 30, p. 110.)

GLENNVILLE & MANASSAS.—A charter has been granted this company in Georgia with an authorized capital of $150,000. The proposed road will be 30 miles long and will extend between the points named above. The incorporators are not given.

GREAT NORTHERN.—The new Whitefish cut-off of this road in Montana has been finished, and the line will shortly be thrown open to regular traffic. The cut-off runs from Columbia Falls, on the present line, to Rexford, a distance of 70 miles. For descriptive article on this work, which has involved a number of difficult engineering problems, see our issue of September 9, page 319.

ILLINOIS CENTRAL.—It is reported that this company has incorporated two new companies at Springfield, Ill., to build branch lines south of Chicago. One is the Kensington & Eastern and the other the Indiana & Kensington. The former will connect the Chicago, Lake Shore & Eastern with the Illinois Central.

INDIANA & KENSINGTON.—See Illinois Central above.

INTERBOROUGH RAPID TRANSIT (NEW YORK).—A formal inspection of the entire subway was made on October 10 by the members of the Rapid Transit Commission, and a certificate has been granted to the Interborough Co. to operate the West Side line from City Hall to 145th street, as the commission is satisfied that the terms of the contract have been complied with in every detail and that the safety appliances are in working order. A certificate to operate the East Side line from 96th street to West Farms was not granted, however, and it is said that there is some doubt as to whether this line will be put in use on October 27, the date set for opening the lines to the public.

JELLICO, BARBOURSVILLE, MANCHESTER & BEATTYVILLE.—Press reports state that this company has been organized in Tennessee to build a railroad from Jellico, Tenn., northeast to Beattyville, Ky., 70 miles. The names of the incorporators are not stated.

KENSINGTON & EASTERN.—See Illinois Central above.

MEXICAN ROADS.—A concession has been granted by the Mexican Government to a syndicate of New York, Chicago and Detroit bankers for building a railroad 200 miles long from Toluca, Mex., to Canango, with a branch from Toluca to the Sultpec mining district. H. B. Hollins, of New York, is said to be interested in the project.

NEW BERLIN & WINFIELD.—An officer writes that contracts for building this line will be let within a few weeks. The proposed route is from Winfield, Pa., to New Berlin, eight miles. The work will be light with easy curves and gradients. I. C. Burd, Shamokin, Pa., is President. (October 7, p. 119.)

OREGON & SOUTHEASTERN.—Work will be begun within a few weeks on an extension of this road from Cottage Grove, Ore., to Orseco, four miles. The line is in operation at present between Wildwood and Cottage Grove, 17 miles. A. B. Wood, Cottage Grove, Ore., is Chief Engineer. (May 27, p. 410.)

PORT ANGELES & EASTERN.—According to newspaper reports, the British-American Finance Co. has been organized to build this road from Port Angeles, Wash., to Olympia, 135 miles. Surveys for the entire line have been completed and 10 miles have been graded out of Port Angeles. G. A. Cushing, Port Angeles, is President. (April 29, p. 336.)

PRINCE EDWARD ISLAND.—Bids will be received until October 24 for grading and track laying on a proposed branch 4½ miles long to Vernon River bridge, P. E. I., and for building a branch line 6.3 miles long to Montague bridge. Plans, profiles and specifications may be seen at the engineer's office at Charlottetown, and at the office of the Chief Engineer at Moncton, N. B.

ROCK LICK & WOLF CREEK VALLEY.—Incorporation has been granted this company in West Virginia to build a railroad from the mouth of Rock Lick Creek to Wolf Creek Valley, where connection will be made with the Deepwater railroad. J. M. Richards, A. D. Smith, S. T. Carter and others, of Fayetteville, W. Va., are named as incorporators.

ROGUE RIVER VALLEY.—A charter has been granted this company at Milford, Ore. The proposed route of the railroad is not stated. W. S. Barnum is said to be interested.

SOUTH GEORGIA & WEST COAST.—It is announced that this road has been extended from Sirmans, Fla., south to Perry, 16 miles, and that the line is now open for traffic between these points. J. W. Oglesby, Quitman, Ga., is President. (See Construction Supplement.)

SUMPTER VALLEY.—This road has been extended from Sumpter, Ore., to Tipton, 23 miles, and is now open for traffic. (See Construction Supplement.)

TALLULAH FALLS.—This road, which runs from Cornelia, Ga., through Turnerville and Tallulah Falls to Tiger, 32 miles, has been extended three miles north of Tiger to Clayton. W. S. Erwin, Cornelia, Ga., is General Manager.

TENNESSEE, GEORGIA & SOUTH CAROLINA (ELECTRIC).—Articles of incorporation have been filed by this company in Georgia. It is proposed to build an electric railroad from Clayton, in Rabun County, Ga., west through Union and Fannin Counties to Ducktown, Tenn., and thence through Walker County to Chattanooga. Merrill Skinner, Blue Ridge, Ga., is said to be interested.

RAILROAD CORPORATION NEWS.

BOSTON & MAINE.—The report of this company for the fiscal year ending June 30 shows gross earnings of $34,894,608, an increase of $1,155,624. Operating expenses were $25,271,908, an increase of $1,038,536, leaving a gain in net earnings of $117,089. Of the total increase in gross earnings, passenger traffic contributed $222,067 and freight traffic $823,322. The increase in

operating expenses was largely due to the high cost of locomotive fuel on account of the coal strike last year, which resulted in an expenditure for this item alone of $600,000 more than under normal conditions. After subtracting all fixed charges and sinking fund payment, the balance available for dividends was $1,849,456. As total dividends amounted to $1,778,999, the balance in excess of all charges and dividends carried over to the contingent fund was $70,457. The more important statistics of operation follow:

	1904.	1903.
Gross earnings	$34,894,608	$33,738,984
Passenger earnings	13,971,273	13,649,598
Freight earnings	20,788,779	19,965,457
Operating expenses	25,271,908	24,233,372
Net earnings	9,622,701	9,505,612
Net income	2,000,741	1,793,909

Chicago Great Western.—The report of this company for the fiscal year ending June 30, 1904, shows gross earnings of $8,022,673, as against $7,823,191 last year, an increase of $199,482. Operating expenses were $5,904,057, an increase of $469,427, leaving a decrease in net for the year of $282,032. The regular dividend on the preferred A stock was paid for the first half of the year. Owing to unfavorable weather and the large increase in operating expenses resulting during the last half of the year, the second semi-annual dividend was passed.

Cripple Creek Central.—See Denver & Southwestern below.

Delaware, Lackawanna & Western.—This company has decided not to renew its contract with the Starin Transportation Co. for the lighterage of its freight in New York harbor. The road has decided to acquire a harbor fleet of its own and do its own lighterage business.

Denver & Southwestern.—The reorganization of this company has been completed and a new corporation, known as the Cripple Creek Central railroad, will take over the property. The new company will have $3,000,000 4 per cent. non-cumulative preferred stock and $2,500,000 common stock. There will be no bonded or floating debt. The officers of the new company are: H. M. Blackmer, President, and R. E. F. Flinsch, New York, Vice-President.

Erie.—The pamphlet report of this company for the year ended June 30 shows gross earnings of $45,201,163, a decrease of $629,250 from 1903, and an increase of $2,656,079 in operating expenses, leaving a decrease in net for the year of $3,285,329. The increase in operating expenses was largely due to the cost of labor, as 60.5 per cent. of the total operating expenses were paid direct to this source during the year. The decrease in merchandise receipts was $1,269,149. Against this there was an increase in passenger traffic of $55,572, and $716,967 more in revenue was secured from the transportation of coal. The maintenance of way charges increased $304,443. The damage caused by the flood of October of last year, the most serious in the history of the company, required large expenditures for repairs. Conducting transportation increased $1,392,488, due to the higher wages paid. The funded debt increased $3,860,000 during the year. There was expended $2,250,468, for improvements and additions, of which $1,540,320 was charged to income account and $710,147 against the amount set aside from income the previous year. President Underwood, referring to the termination of the voting trust, says that during its administration the gross earnings of the road have increased from $28,185,876 in 1895 to $45,201,163 in 1904.

Maine Central.—The report of this company for the fiscal year ending June 30 shows gross earnings from all sources of $6,991,622, an increase over last year of $257,137. Operating expenses were $5,101,543, an increase of $219,277, leaving an increase in net earnings of $37,860. Of the increase in gross earnings, passenger earnings contributed $81,085 and freight earnings, $151,315. The increase in operating expenses was due to advances in the wages paid and the higher cost of fuel. The equipment and rolling stock was increased during the year by the addition of four locomotives, six passenger cars, 500 box cars and 100 coal cars at a total cost of $542,554. Of this amount, $490,317 was provided from the equipment appropriation of last year and the remaining $52,237 was included in operating expenses. After payment of all fixed charges and dividends, the surplus for the year was $83,305, a decrease over last year of $25,523.

Manistee & Grand Rapids.—This road was sold on October 5 to a syndicate of capitalists of which J. Crocker, of Chicago, is President, and Max Toiz, Vice-President and General Manager. The syndicate has acquired a large water front in Detroit, and other property, and work will be begun at once on an extension of the line to Marion to give an eastern outlet connecting with the Ann Arbor railroad.

Maryland, Delaware & Virginia.—This new company has been formed to take over the Queen Anne's Railroad, the Chester River Steamboat Co. and the Weems line of steamers, doing business between Baltimore and the eastern shore of Maryland and Virginia. The properties merged have a total capitalization of $4,015,000. The railroad, which is 80 miles long, running from Love Point, Md., to Rehoboth, went into the hands of a receiver in March, 1904.

Missouri & Illinois Bridge & Belt.—This company has been formed as the reorganization of the Alton Bridge Co., and the directors include: C. S. Clarke and E. T. Jeffery, of the Gould Lines; B. L. Winchell, of the Rock Island; M. H. Smith, of the L. & N.; M. E. Ingalls, of the Big Four; James McCrea, of the Pennsylvania; Joseph Ramsey, Jr., of the Wabash; R. W. Maguire, of the M., K. & T.; O. G. Murray, of the B. & O., and A. J. Davidson, of the St. Louis & San Francisco. The directors held a meeting on October 8 and elected the following officers: Joseph Ramsey, Jr., President; A. J. Davidson, Vice-President; F. H. Hamilton, Treasurer, and E. D. Taylor, Secretary. The new company will take possession of the bridge at once.

New York Central & Hudson River.—This company has made application to the New York stock exchange to list $5,000,000 of its 3½ per cent. mortgage bonds. These bonds are of the series of $100,000,000 3½ per cent. 100-year gold bonds due in 1997. Of this issue, $15,000,000 was reserved for additions and improvements after 1903, and of this amount $11,000,000 has already been spent. The present issue of $5,000,000 is purely for refunding purposes.

Queen Anne's.—See Maryland, Delaware & Virginia above.

St. Louis, Memphis & Southeastern.—Farson, Leach & Co., New York, are offering the 4½ bonds of this company on an approximately 5.10 per cent. basis. For a full description of this new railroad see the main part of this week's issue.

Wabash.—The report of this company for the fiscal year ending June 30 shows gross earnings of $23,023,626, an increase of $1,882,797 over last year. Operating expenses were $17,683,509, an increase of $1,867,846, leaving an increase in net of $14,951. After subtracting all fixed charges and dividends on debenture A bonds, the final surplus for the year was $14,291, as against $196,150 the previous year. This diminution was due in part to large appropriations for additions to the property.

Worcester & Southbridge.—A petition has been made to the Railroad Commission of Massachusetts for its approval of the purchase by the Worcester & Southbridge Railway Co. of the Worcester, Rochdale & Charlton Depot Street Railway. The Worcester & Southbridge has voted to increase its capital stock by $40,000, the additional shares being used to buy the capital stock of the Worcester, Rochdale & Charlton Depot line.

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EDITORIAL ANNOUNCEMENTS:

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CONTRIBUTIONS.—Subscribers and others will materially assist in making our news accurate and complete if they will send early information of events which take place under their observation. Discussions of subjects pertaining to all departments of railroad business by men practically acquainted with them are especially desired.

ADVERTISEMENTS.—We wish it distinctly understood that we will entertain no proposition to publish anything in this journal for pay, EXCEPT IN THE ADVERTISING COLUMNS. We give in our editorial columns OUR OWN opinions, and these only, and in our news columns present only such matter as we consider interesting and important to our readers. Those who wish to recommend their inventions, machinery, supplies, financial schemes, etc., to our readers, can do so fully in our advertising columns, but it is useless to ask us to recommend them editorially either for money or in consideration of advertising patronage.

FRIDAY, OCTOBER 14, 1904.

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